IRRIGATION ENGINEERING CENTER PROJECT PHASE II
IN
THE KINGDOM OF THAILAND

DETAIL DESIGN REPORT
ON
THE FACILITY FOR TELEMETERING AND DATA COMMUNICATION SYSTEM

JULY, 1991

JAPAN INTERNATIONAL COOPERATION AGENCY

THE KINGDOM OF THAILAND

REPORT

ON

IRRIGATION ENGINEERING CENTER PROJECT

PHASE II

THE JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)
Tokyo, Japan

PREFACE

The Irrigation Engineering Center Project (Phase II) (hereinafter referred to as "the Project") aims at securing and maintaining stable agricultural production and improving agricultural farm management by using as effectively as possible the limited water resources available in the Kingdom of Thailand. The Project has been started its activities in the preceding since April 1, 1990.

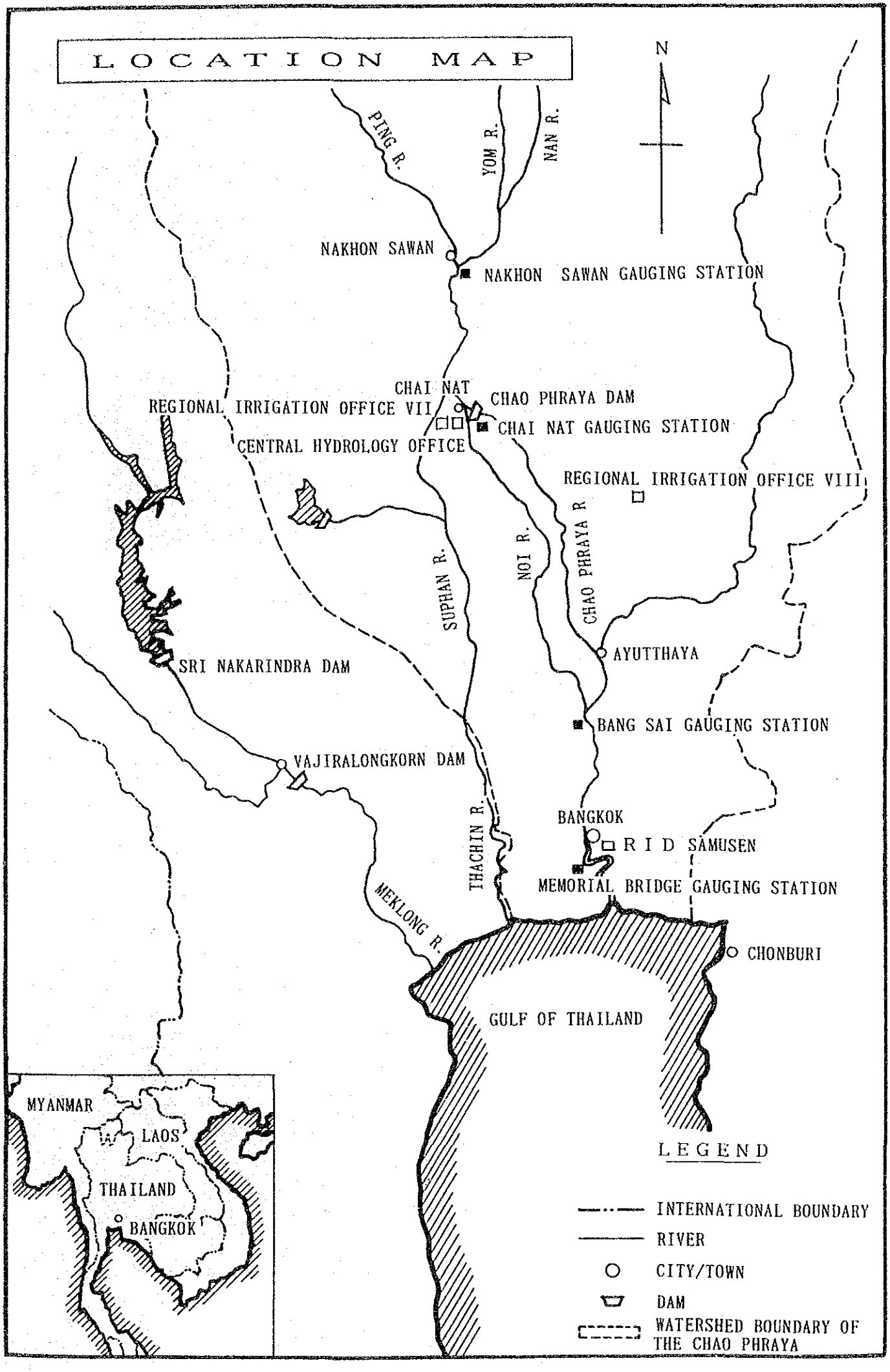
The team, headed by Mr. Yukiharu HARADA, Director, Kiso-River Basin Agricultural Land and Water Planning and Management Office, Tokai Regional Administration Office, Ministry of Agriculture, Forestry and Fisheries was dispatched to Thailand from March 28, 1991 to May 11, 1991 for the purpose of detail design of the facility for telemetering and data communication system as the model infrastructure improvement in order to contribute to solve technical problems concerning the improvement for water management.

This report represents the results of the field survey and a subsequent study in Japan. We hope that this report will serve as a guideline for the model infrastructure improvement project being expected in the future.

Lastly, we take this opportunity to express our deep gratitude to all those who were concerned with us for the close cooperation and assistance they extend to the team throughout the survey period.

July 1991

Nobuyoshi SAKINO
Director
Agricultural Development
Cooperation Department,
Japan International
Cooperation Agency, JICA


LOCATION MAP
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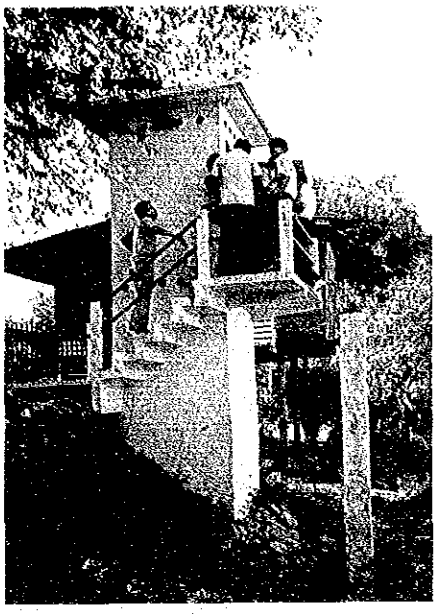
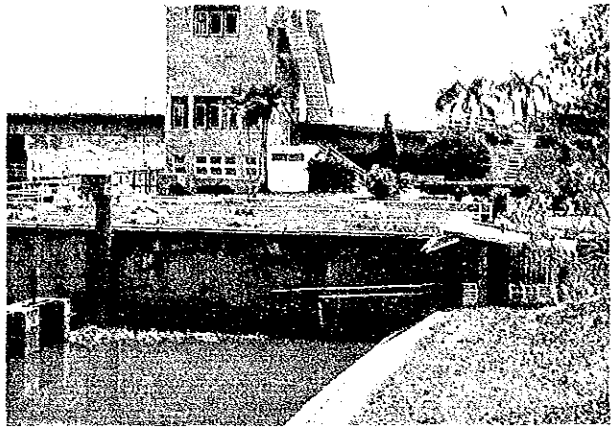
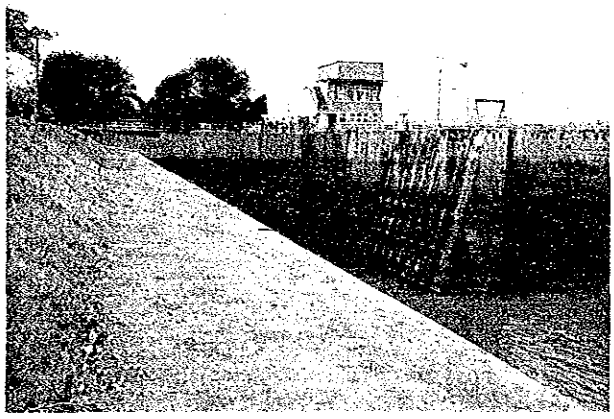
PING R.
YOM R.
NAN R.
NAKHON SAWAN
NAKHON SAWAN GAUGING STATION
CHAI NAT
CHAO PHRAYA DAM
REGIONAL IRRIGATION OFFICE VII
CHAI NAT GAUGING STATION
CENTRAL HYDROLOGY OFFICE
REGIONAL IRRIGATION OFFICE VIII
SUPHAN R.
NOI R.
CHAO PHRAYA R.
AYUTTHAYA
SRI NAKARINDRA DAM
BANG SAI GAUGING STATION
VAJIRALONGKORN DAM
BANGKOK
THACHIN R.
R I D SAMUSEN
MEMORIAL BRIDGE GAUGING STATION
MEKLONG R.
CHONBURI
GULF OF THAILAND
MYANMAR
LAOS
THAILAND
BANGKOK
LEGEND
INTERNATIONAL BOUNDARY
RIVER
CITY/TOWN
DAM
WATERSHED BOUNDARY OF THE CHAO PHRAYA



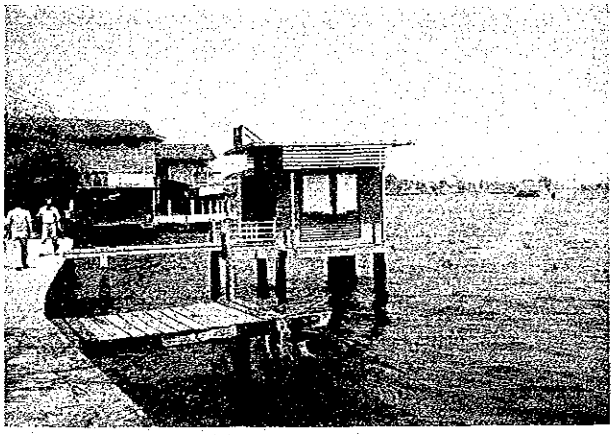
ナコンサワン水位観測所
C_2 WATER LEVEL GAUGE
(NAKHON SAWAN)



チャイナートダム上流側水位計
WATER LEVEL GAUGE AT UPSTREAM
OF CHAI NAT DAM



チャイナートダム下流側水位計
WATER LEVEL GAUGE AT DOWNSTREAM
OF CHAI NAT DAM



メモリアル橋水位観測所
C_4 WATER LEVEL GAUGE (MEMORIAL BRIDGE)

CONTENTS

CHAPTER 1. DISPATCH OF DETAILED DESIGN STUDY TEAM

1-1. BACKGROUND O F DISPATCH OF STUDY TEAM AND PURPOSE

In Thailand, rice is the key agricultural product, and the rice cropping area of 11.9 million hectares account for about 60 percent of the total cultivated area of the country. And about 34 percent of the total rice production has been exported.

The irrigated farm land is about 3.9 million hectares, occupying only about 20 percent of the total farm land of about 19.5 million hectares. In view of the characteristic feature of Thai agriculture with rice cropping as core, it is clear that irrigation plays a vitally important role to stabilize its economy.

The Irrigation Engineering Center (IEC) was established as the base for the development of appropriate irrigation/drainage technology and upbringing of the engineers with high level of technique on planning, designing and construction of the best-suited irrigation/drainage facilities, so as to promote increase in food production and consolidation of agricultural infrastructures in Thailand.

The IEC Project had served in the following five fields for five years from April, 1985 to March, 1990, and successfully brought the fruitful results.

① design criteria of various facilities,
② hydraulic model tests,
③ construction materials tests,
④ system development and
⑤ training.

On the other hand, it is very important for Thailand to develop and ensure water resources and to consolidate irrigation/ drainage facilities so that not only agricultural production can be increased but also the living standard of the farmers can be stylized by introduction of cash-crops in the dry season.

The Royal Irrigation Department (RID) was tasked to carry out the studies, plannings, construction works of the irrigation/drainage project together with their operation and maintenance services, and the improvement and innovation of these operation and maintenance services by RID have become an important aspect for old and new irrigation/drainage facilities, such that projects are spreading throughout the country.

The five-year technical cooperation for IEC has started since April, 1990 as Phase II so as to make the existing water resources used most effectively through improving of water management technology. The following are the cooperation items in the IEC Project Phase II.

1) Water Management

① Observation and collection of water management data, and the improvement of the related technology
② Improvement of water distribution technology
③ Development of an effective methods of discharge analysis for hydrological analyses of water management

2) Hydrological Analysis

① Development of water balance computation method for runoff ratio analysis
② Development of water balance computation method for water resources development
③ Study of observation method for irrigation water quality control

3) Data/Information Control System

① Development and arrangement of computation system for water management for technology
② Technological innovation of data/information collection and control for irrigation projects.
③ Study of networks system for technological data/information of irrigation

4) Design of Irrigation / Drainage Facilities

① Preparation of design criteria and standards, and preparation of manuals and their distribution.
② Improvement of technology for construction and operation/ maintenance of major irrigation facilities

5) Training

① Preparation of guidance and advice for training

In January, 1990, a contact mission was dispatched to Thailand to hold the consultative discussion meetings and to make the five-year work plan for the project. The mission understood the data communication system (the system) would be inevitable for successful implementation of water management in the irrigation projects.

Hence, the detailed design study team was dispatched to the field to carry out the detailed design for establishing the systems. The purpose of the team to make detailed design, cost estimation, etc. for the technical innovation for a successful water management.

The scope of works of the team is to carry out a detailed design, as well as prepare the draft bid documents for telemetering system including automatic observation equipment and data communication system based on the water management plan.

1-2. MEMBERS OF THE STUDY TEAM AND COUNTERPARTS PERSONNEL

(1) Study Team Members

Team Leader	Mr. Yukiharu Harada
Irrigation Engineer	Mr. Hiroshi Kondo
Mechanical Engineer	Mr. Ikuo Komagata
Data Communication System	Mr. Tomiharu Shimoji
Project Coordinator	Mr. Yuuichi Nobuta

(2) Counterparts Personnel (Working Group)

Mr. Kitcha Polparsi	Deputy Director General for Engineering, RID (Director of Irrigation Engineering Center (IEC))
Mr. Sompote Sukhumpanich	Director of Data Processing Division (Director of System Development Div., IEC)
Mr. Sakulwattana Chantharobol	Director of Operation and Maintenance Division (Director of water Management Div., IEC)
Mr. Prasert Milintangul	Director of Hydrology Division (Director of Hydrological Research & Application Div., IEC)
Mr. Sinserm Kedutat	Director of Communication Division
Mr. Suthi Songvoravit	Chief of Section 1, Project Planning Division (Deputy Director of IEC cum Director of General Management Div., IEC)
Mr. Virat Khao-Upathum	Chief of Water Operation Section 1, 0 & M Div.

1-3. LIST OF MAJOR PERSONNEL CONTACTED

<RID: Royal Irrigation Department>

Mr. Leck Jindasanguan	Director General, RID
Mr. Kitcha Polparsi	Deputy Director General for Engineering, RID (Director of Irrigation Engineering Center (IEC))
Mr. Sompote Sukhumpanich	Director of Data Processing Division (Director of System Development Div., IEC)
Mr. Sakulwattana Chantharobol	Director of Operation and Maintenance Division (Director of Water management Div., IEC)
Mr. Prasert Milintangul	Director of Hydrology Division (Director of Hydrological Research & Application Div., IEC)
Mr. Sinserm Kedutat	Director of Communication Division
Mr. Vichit Vilaikij	Director, Regional Irrigation Office 7
Mr. Suthi Songvoravit	Chief of Section 1, Project Planning Division (Deputy Director of IEC cum Director of General management Div., IEC)
Mr. Supot Promnaret	Chief of Computer Branch, Data Processing Div.
Mr. Chairat Kau-Arun	Chief of Computer Section, Data Processing Div.
Mr. Somnuk Jirasirisopon	Engineer of Computer section, Data Processing Div.
Mr. Wasan Boonkerd	Chief of Engineer Service Branch, O & M Div.
Mr. Virat Khao-Upathum	Chief of Water Operation Section 1, O & M Div.
Mr. Akkapong Boonmash	Water Use Improvement Section, O & M Div.
Mr. Piphat Sathianpantarit	Water Use Improvement Section, O & M Div.
Mr. Apichai Wathanayomnaporn	Water Use Planning Section, O & M Div.

Mr. Prasong Jitseri	Chief of Research and Applied Hydrology Branch, Hydrology Div.
Mr. Amnuey Somsin	Chief of Sediment Investigation Branch, Hydrology Div.
Mr. Atthaporn Boodhapalit	Data Processing and Statistics Branch, Hydrology Div.
Mr. Putchai Nitakorn	Chief of Technical Section, Communication Div.
Mr. Vidhaya Samaharn	Chief of Hydraulic Section, Research and Laboratory Div.
Mr. Aruan Suwannasidh	O & M Div., Regional Irrigation Office 8.

<TOT : Telecommunication Organization of Thailand>

Mr. Chawalit	Manager of Central of Commercial Service, TOT
Mr. Vasukree Klapairee	Central of Commercial Service, TOT

(Japanese Personnel Contracted)

Mr. Kazuo Hirashima	First Secretary, Embassy of Japan
Mr. Nobuji Abe	Resident Representative, Thailand Office, JICA
Mr. Keiichi Kato	Deputy Director, Thailand Office, JICA
Mr. Yoshio Tanigawa	Deputy Director, Thailand Office, JICA
Mr. Junji Yokokura	Assistant Resident Representative, Thailand Office, JICA
Mr. Noriharu Usukine	JICA Expert (IEC)
Mr. Narihide Nagayo	JICA Expert (IEC)
Mr. Hiroshi Eriguchi	JICA Expert (IEC)
Mr. Seiki Momose	JICA Expert (IEC)
Mr. Yoshitaka Kamikataguchi	JICA Expert (IEC)
Mr. Junji Ichikawa	JICA Expert (IEC)
Mr. Sunao Nanguu	JICA Expert (TOT)

1-4. FIELD STUDY ITINERARY

No. of Day	Month Date	Day	Descriptions
1	Mar. 28	Thu.	3 team members arrived at BKK
2	Mar. 29	Fir.	Meeting with JICA experts at IEC on work plan and with RID staff concerned on field study plan, etc.
3	Mar. 30	Sat.	Preparation for field study
4	Mar. 31	Sun.	Data arrangement
5	Apr. 1	Mon.	Meeting with JICA experts at IEC on field study and with RID's Communication Div. on work plan
6	Apr. 2	Tue.	Field study at Bang Sai, Yang Manee Project, etc.
7	Apr. 3	Wed.	Field study at RID provincial office, C_2 water gauging station, RID Regional Irrigation Office 7 & 8, Chao Phraya Dam.
8	Apr. 4	Thu.	Field study at C_4 water gauging station, and meeting with JICA experts
9	Apr. 5	Fir.	Second meeting with RID staff concerned on water gauging station and meeting with JICA expert at TOT on availability of leased line.
10	Apr. 6	Sta.	Data arrangement
11	Apr. 7	Sun.	Mr. Harada, and Mr. Nobuta arrived at BKK, and Team Meeting
12	Apr. 8	Mon.	Courtesy call at JICA BKK office and making reports as well as meeting with JICA expert.
13	Apr. 9	Tue.	Meeting with JICA experts and third meeting with RID staff concerned
14	Apr. 10	Wed.	Messrs. Harada, Nobuta, and Shimoji making field study, and Messrs. Kondo and Komagata preparing data / papers for meeting.

No. of Day	Month Date	Day	Descriptions
15	Apr. 11	Thu.	Meeting with JICA experts, and fourth meeting with RID staff concerned, and data collection for cost estimation.
16	Arp. 12	Fri.	Data arrangement and study on plan.
17	Aprl. 13	Sat.	Data arrangement.
18	Apr. 14	Sun.	Data arrangement.
19	Apr. 15	Mon.	Writing a letter to RID by team leader.
20	Apr. 16	Tue.	Fifth meeting with RID staff concerned and team meeting on study policy in future, making report to JICA BKK; and Messrs. Harada and Shinoda left BKK for Japan.
21	Apr. 17	Wed.	Data collection for cost estimation.
22	Apr. 18	Thu.	Messrs. Shimoji & Komagata making field study, and Mr. Kondo holding a meeting with Hydrology Div.
23	Apr. 19	Fri.	Messrs. Shimoji & Komagata making field study, and Mr. Kondo collecting data for contracting procedures.
24	Apr. 20	Sat.	Data arrangement.
25	Apr. 21	Sun.	Data arrangement.
26	Apr. 22	Mon.	Checking the existing graphic panel, and study of the planning, tender documents, etc.
27	Apr. 23	Tue.	Study of the planning, tender documents, etc. and data collection for cost estimation, and field study at C_4.
28	Apr. 24	Wed.	Study meeting with JICA experts on telemetering system, and study on the planning, tender documents, specifications, etc.

No. of Day	Month Date	Day	Descriptions
29	Apr. 25	Thu.	Mr. Komagata making courtesy call at JICA BKK for his leaving for Japan, and study of planning, bid documents and specification.
30	Apr. 26	Fri.	Mr. Komagata left BKK for Japan.
31	Apr. 27	Sat.	Data arrangement.
32	Apr. 28	Sun.	Data arrangement.
33	Apr. 29	Mon.	Study on water level gauging station and technical specifications.
34	Apr 30	Tue.	Study of water level gauging station and specifications, and meeting with RID's System Development Div.
35	May 1	Wed.	Meeting with RID's System Development Div. and study of the plan.
36	May 2	Thu.	Mr. Kondo making field study and study of the plan.
37	May 3	Fri.	Meeting with JICA experts and study of the plan.
38	May 4	Sat.	Data arrangement.
39	May 5	Sun.	Data arrangement, and preparation of draft report.
40	May 6	Mon.	Data preparation for meeting.
41	May 7	Tue.	- ditto -
42	May 8	Wed.	Meeting with JICA experts, and preparation of draft report.
43	May 9	Thu.	Last meeting with RID staff concerned and courtesy call at JICA BKK office to make report and greet for leaving BKK for Japan.
44	May 10	Fri.	Data arrangement.
45	May 11	Sat.	Messers. Kondo & Shimoji left Bangkok for Japan.

ORGANIZATION OF ROYAL IRRIGATION DEPARTMENT

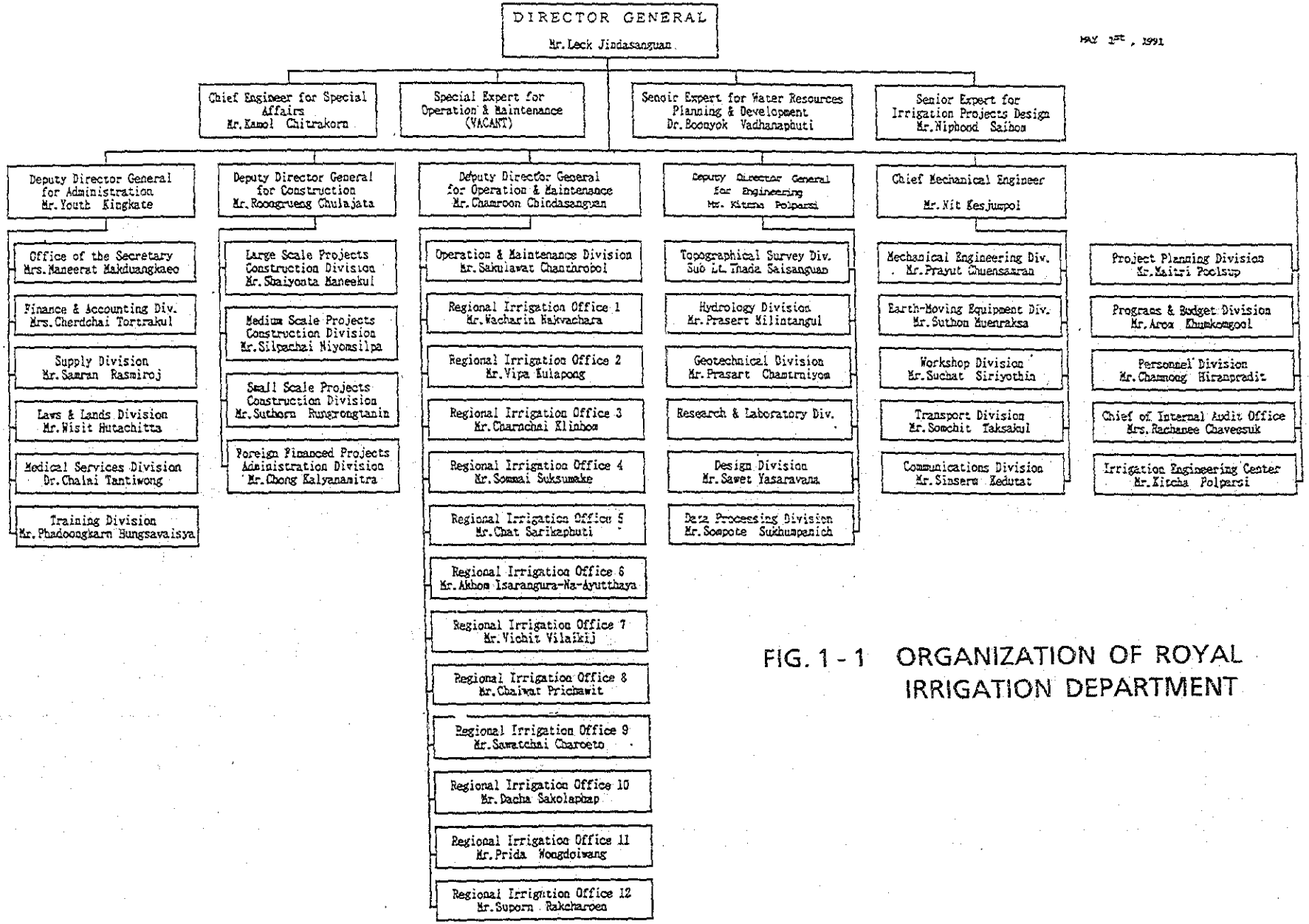
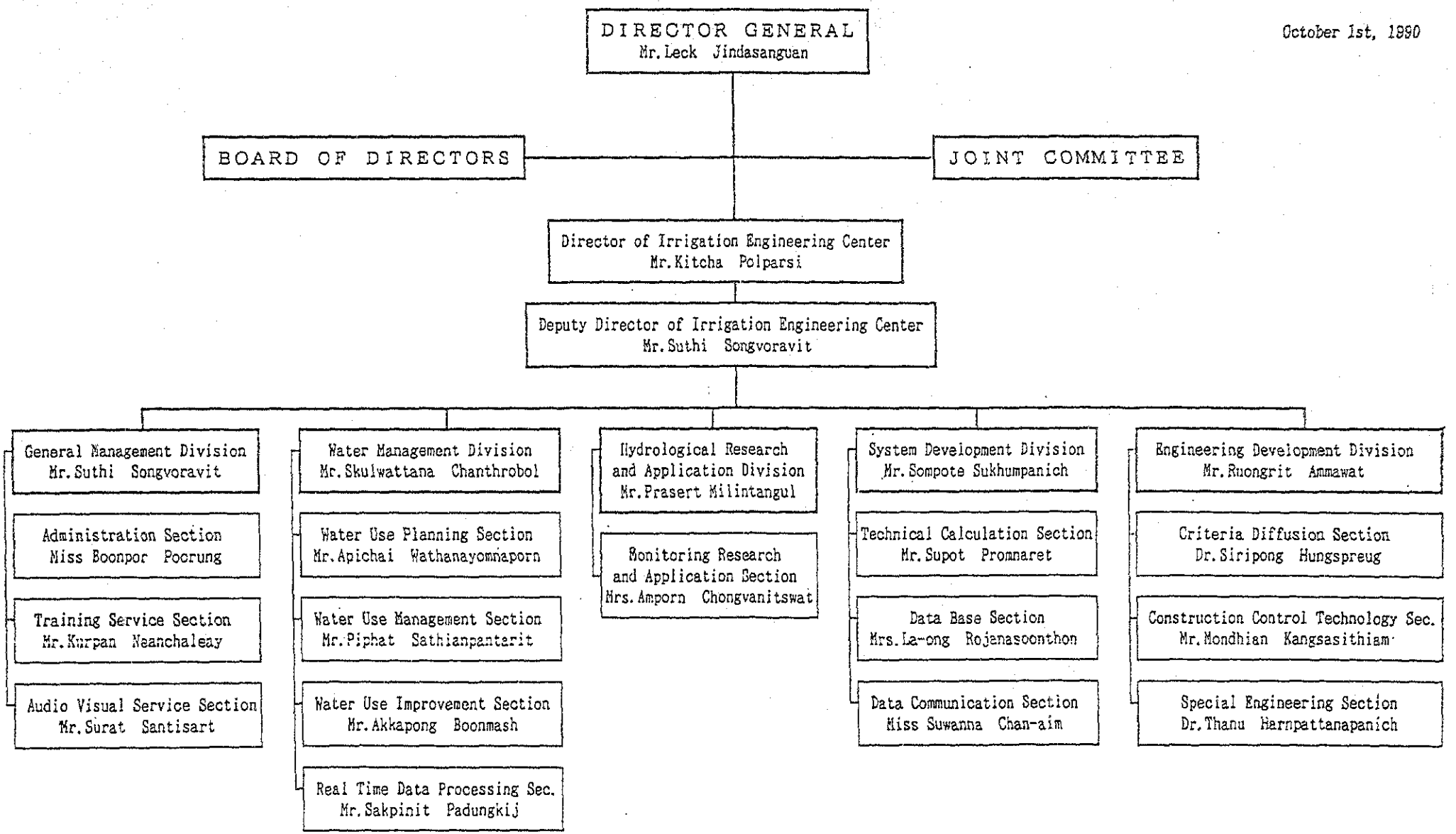


FIG. 1 - 1 ORGANIZATION OF ROYAL IRRIGATION DEPARTMENT

FIG. 1-2 ORGANIZATION OF IRRIGATION ENGINEERING CENTER

October 1st, 1990



CHAPTER 2. PLANNING

2-1. BASIC CONCEPT OF WATER MANAGEMENT SYSTEM

1) Present and Future of Irrigated Agriculture

Agriculture in Thailand has been prosperously developed with the Chao Phraya Plain (sometimes called as the Chao Phraya delta) located in the center of the country as core. The Thai agricultural development can be generally divided into two stages of ① production increase stage by farm land expansion, and ② production increase stage by supplemental water supply with rainfed.

The development for irrigated agriculture in the Chao Phraya Plain at the stage of production increase by farm land expansion was commenced at the beginning of the establishment of RID. As such, the irrigation and drainage system in the plain varied from 30 - 50 years old or more. They were constructed on the lower left bank in the 1930's, on the lower right bank in the 1950's and on the upper plain in the 1960's.

The very competitive Thai rice in foreign rice market was depending on the expansion of cropping area for production increase to satisfy the food demand and export. Unfortunately, however, further expansion of farm land in acreage cannot be expected in the Chao Phraya Plain.

In cope up with the problem, great efforts have been made to increase farm land productivity through construction, consolidation, and effective operation of irrigation and drainage facilities, and development of water resources.

Consequently, new and diversified water utilization schemes have been developed for the dry season rice, upland crops, tree, crops, etc. in addition to the wet season rice. And much endeavor has been made to practice the effective water management for the situation, but due to recent rapid increase in the diversified demand of water has not been able to be fulfilled with the current measures of the water management.

Agricultural productivity in Thailand plays a vitally important role in its national policy as well as the industrial productivity. The land and water resources in the country have become a major restrictive factor.

And, hence, the fundamental conditions presented in considering the future development of the irrigated agriculture in Thailand will be decrease in irrigation water demand through introduction of up-land crops, intensive farming of highly profitable crops, education and training of the local farmers, establishment of cooperative organizations as well as precise, even and stable water supply.

2) Present Water Management

Most irrigation water for the Chao Phraya Plain are originating from the Chao Phraya River. At the point about 60 km downstream from Nakhon Sawan, there is the Chao Phraya Dam which is the largest dam on the Chao Phraya River. Between Nakhon Sawan and the Chao Phraya Dam, there are the Phonlathep Regulator the Borommathat Regulator and the Monoram Intake. The total irrigation areas command by four water intakes including the one for the Chao Phraya Dam are about 5,000,000 Rai (abt. 800,000 ha), for which 25 project offices are in service of operation and maintenance.

The RID's Operation and Maintenance Division (O/M Div.) is in charge of controlling the gate of the structures on the Chao Phraya River, while the Regional Irrigation Offices control those along the respective main canals. In carrying out such gate operation, the project office submit reports on matters like water level at up- and downstream of the regulators, discharges, gate opening degrees, rainfall, etc. necessary for gate control to RID Headquarter and Regional Irrigation Offices concerned. The information on the cropping pattern and the cropping area are sent to Regional Irrigation Office and RID Headquarter weekly.

These data are transmitted through radio networks under the control of the RID's Communication Division.

The radio communication system is manually operated and as such is subject to meteorological and climatological conditions, that can cause interruptions and troubles in transmission of precise informations.

The data received by RID's Communication Division, are filled out onto specific data forms and delivered to the O/M Div.

The collected data are stored in each project office, Regional Irrigation Office, and the O/M Div. It is not so easy, however, to make better use of these stored data.

3) Basic Concept of Water Management

Naturally firm grasp of potential water for water resources development plan. In view of water use, however, the water potential should be ensured for availability of water, and in another view of water demand, the necessary water amount should be clarified as well. In the relationship between the water availability and potentiality, the necessary water amounts should be estimated to be the base of the water resources development plan.

Water resources management is to be applied in the distribution of water in macro scale i.e. involving a large water basin for effective water utilization.

The water management is a series of works practised at sites to materialize the water plan in taking into account changes of the situation, in other words, the movable parts of various facilities provided in the basin shall be controlled in high consistency according to results of analysis of the real-time data collected along the instruction, standards and targets.

Theoretically, the gates or any other movable parts' operation well-controlled in high consistency will be enable to realize the aforesaid the most ample water distribution together with the verification and correction of a variety of actual data collected.

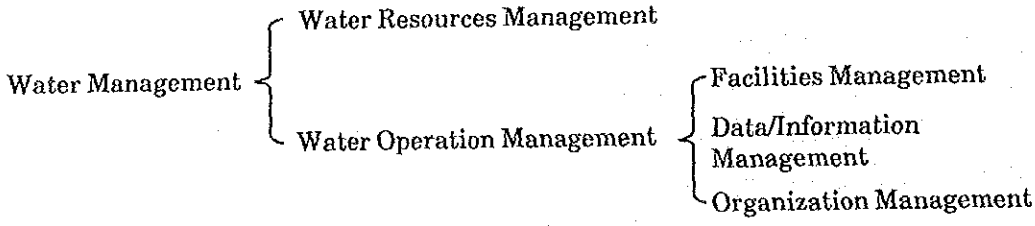
Water management can be specified into three fields as follows: ① facilities management, ② data/information management, and ③ system management.

The facilities management is concerned with the irrigation and drainage facilities, their maintenance including operation of movable parts of the structure, while the data/information management is concerned with

collection, transfer and control of data on rainfall field moisture, cropping plan discharges in rivers, canals, etc. and operation condition of the related facilities.

The organization management means of control the organizations composed of such human resources as those working in the facilities and data/ information managements.

A consideration on water management can be shown as follows:



4) Water Management Plan in Technical Cooperation in IEC

The frame work of the work plan for technical cooperation in IEC Project Phase II, which was started in 1990, as discussed in Chapter 1, out of which the works concerning with the water management field are mentioned below.

a) Technical Cooperation Activities through Water Management Data Networks System

* Innovation of technology of observation and collection of water management data (Water Management Field)

* Innovation of water distribution technology (Water Management Field)

* Development of Technology for discharge analysis for water management (Water Management Field)

* Technical innovation for hydrological analysis (Hydrology Field)

* Development and support on the systems for the operation of the water management data communication system. (System Development Field)

b) Other Activities for the Water Management Work Improvement

* Innovation of water distribution technology
(Water Management Field)

* Development of discharge analysis for water management
(Water Management Field)

2-2. SCOPE OF THE WORKS FOR MODEL INFRASTRUCTURE

The purpose and scope of the Model Infrastructure Project to the IEC Project Phase II are mentioned as follows.

As referred to previously, RID has provided many dams, water intake, irrigation and drainage facilities for securing water along the Chao Phraya River as the important water sources of the Chao Phraya Plain, but irrigation water shortage has taken place in the area these few years.

Under the circumstances, RID has become urged to make the most effective use and possibly even distribution of the limited water resources, and the IEC Project Phase II has come to take up the water management sector as an important part of the cooperation.

The Chao Phraya River, is a very large river with a catchment area of about 180,000 sq.km and flow distance of 1,000 km, but the river slope in the downstream is too small to catch the discharges correctly and a great deal of data will have to be treated appropriately quickly for the purpose. Such works will have to provide a considerably sophisticated systems for adequate water management. Model system will be constructed in this model infrastructure project so as to consolidate the working environment of survey and study for appropriate water management through the current technical cooperation.

The model system shall introduce the telemetering and data communication system to collect and treat data for grasping the discharges at various important sites in the downstream from Nakhon Sawan along the Chao Phraya River.

These system will enable to do

a) real-time data collection and analysis of the discharges at every important sites, and
b) real-time collection and analysis of important data,

so as to carry out survey and study on appropriate water management in the basin as well as to make better facilities management through proper operation.

Particularly, the current study with model system places stress on,

a) Gathering and analysis of reverse flow conditions of brackish water.
b) Study of the effective water management on the gates.

In the above view, the following four sites are selected for observation points of the telemetering systems on water level and rainfall.

① Nakhon Sawan, ② Chao Phraya Damsite
③ Bang Sai, and ④ Memorial Bridge in Bangkok City

The reasons for their selection are as follows;

① Nakhon Sawan : Many tributaries join at the upstream of Nakhon Sawan from which the Chao Phraya River starts, and the amount of potential irrigation water in the Plain can be estimated from the data collected at this point. The existing RID's C_2 water gauging station is to be used.

② Chao Phraya Dam : The Chao Phraya Dam is the only one dam in the southern part of Nakhon Sawan, and provides most of all water intakes for irrigation. This is

the most important point to grasp the necessary status of irrigation water intake. Water level gauges are placed up- and downstream of the dam.

③ Bang Sai : Bang Sai is the limit point where brackish water comes up and serves for grasping and analyzing the brackish water flow as well as for the point to gate for the irrigation and drainage in the downstream from the Chao Phraya dam. A new water gauging station is to be provided here.

④ Memorial Bridge : This site is directly affected by sea tide and quite an important point to observe the discharge in the downstream from Bang Sai to the estuary as well as the influence of water management of agricultural land vicinity of Bangkok.

The data communication system for data transmission of water management will be introduced between IEC and Central Hydrology Office, Regional Irrigation Office 7 & 8.

2-3. TRANSMISSION SYSTEM

2-3-1. Introduction

It is indispensable to secure a reliable transmission system in order to send observed and collected data from the gauging stations, Regional Irrigation Offices and Central Hydrology Office to the master station in real time or timely.

The following two transmission systems are the subject for study as mentioned in the "Report on the Master Plan of the Network System for the IEC Project".

- Utilization of leased line to be furnished by Telephone Organization of Thailand (TOT).

- Establishment of private radio transmission system.

However, it can be said that the utilization of a leased line is most appropriate selection, if it is available.

2-3-2. Availability of Leased Line

As the result of the site survey for proposed site for Bang Sai gauging station, it is found out that the public telephone service is available the neighboring area by Bang Sai local exchange office. Therefore, there is no serious problem with utilization of a leased line for the new telemetering/data communication system.

Furthermore, possibility of utilization of a leased line shown in Fig. 2-1 has been confirmed through a meeting with the staffs of TOT (Central Commercial Service) unofficially.

2-3-3. Technical Advantages of Leased Line

The leased line has the advantages against the private radio transmission system as mentioned below:

(1) Leased lines will provide the same quality and reliability of the telecommunication networks which are being used as the public telephone service since the leased lines are parts of the public telecommunication networks is furnished.

(2) The public telecommunication networks gives good performance in both the quality and reliability as compared to a private radio transmission system, since the public telecommunication networks are so designed and built to satisfy the recommendations (technical requirement and performance) presented by the CCITT* and CCIR** except spur links and/or local links of the public telecommunication networks partially, further operation and maintenance are carried out systematically by well trained engineering groups.

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* CCITT : From the French for International Telegraph and Telephone Consultative Committee. The CCITT is one of the four permanent organ of the International Telecommunication Union.

** CCIR : From the French for International Radio Consultative Committee. The CCIR is one of the four permanent organ of the International Telecommunication Union.

(3) The public telecommunication networks consist of several subsystems, i.e., telephone exchange, telegraph exchange, radio transmission, cable transmission and power supply subsystem and each subsystem has a stand-by subsystem in order to relieve the trouble.

In contrast to this, the private radio transmission system has usually no stand-by system because they give priority to cost saving rather than system performance.

Simplified system configuration of ratio and power supply systems for both public and private telecommunication networks are shown in Fig. 2-2 and Fig. 2-3.

2-3-4. Economic Comparison

(1) TOT Leased Line

Installation cost and monthly charge of the leased line are estimated as shown below:

a) Installation Cost	:	30,150 Bahts
b) Monthly Charge	:	102,000 Bahts

(2) Private Radio Transmission System

Design criteria for setting up a private radio transmission system is as follows.

a) Radio Frequency	:	400 MHz
b) No. of Radio System	:	One system (No stand-by system)
c) Signal to Noise Ratio	:	35 dB
d) System Reliability	:	95.0%
e) Power Supply System	:	AC Commercial Power Except R-3 (Solar battery is introduced for R-3)

A site and route selection for the radio transmission system which interconnects all the gauging stations and the offices concerned were

carried out by using a topographic map and field survey. The selected route of the transmission system and all the radio paths are shown Fig.2-4.

The summary of the estimated cost is shown below:

a) Radio System	:	4,169,000	Bahts
b) Power Supply System	:	1,090,000	
c) Installation Cost	:	1,840,000	
d) Antenna Tower	:	6,000,000	
e) Training	:	351,000	
Total		13,450,000	

Note: Import tax and custom clearance are not included.

(3) Economic Comparison

A simple economic comparison between the leased line and the private radio transmission system was made under the condition shown below:

a) Life of the private radio transmission system : 15 years

b) Operation and maintenance cost of the private radio transmission system : 5% of the installation cost

The total amount of the installation cost and operation and maintenance cost of the private radio transmission system for 15 years comes to 23,537,500 Bahts as computed below.

$$13,450,000 + (13,450,000 \times 0.05 \times 15) = 23,537,500$$

On the other hand, the total amount of the installation cost and the rental charge of the leased line for 15 years runs up to 18,390,150 Bahts as shown below.

$$30,150 + (102,000 \times 12 \times 15) = 18,390,150$$

To lease TOT line is much advantage than the establish of private system in economical view point.

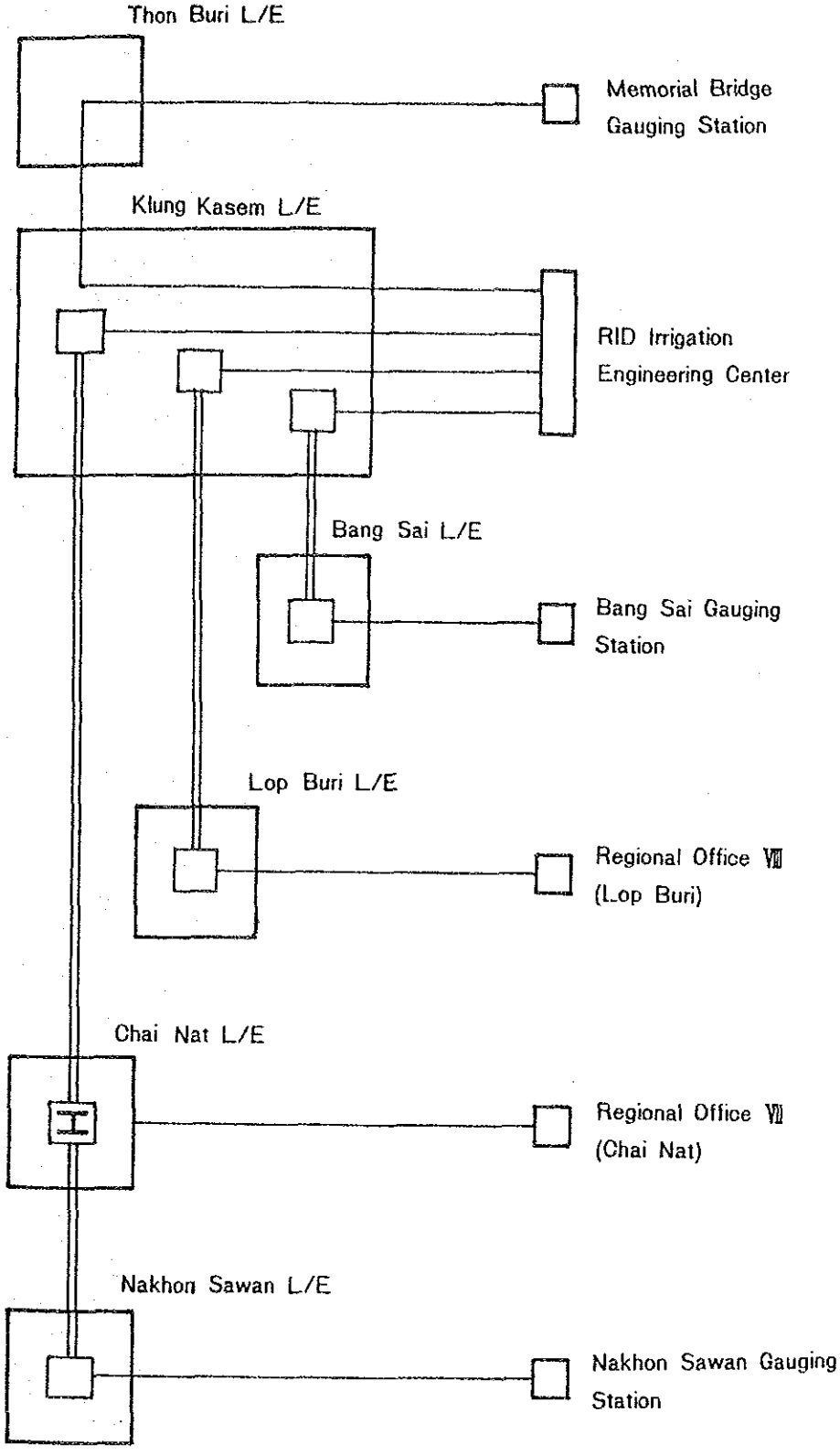
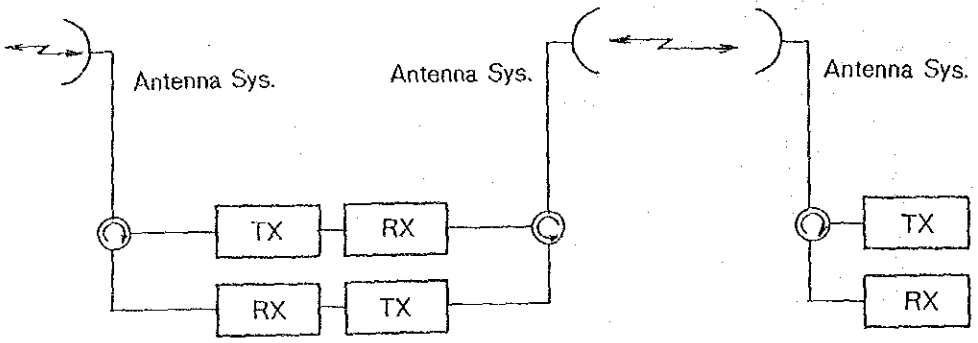
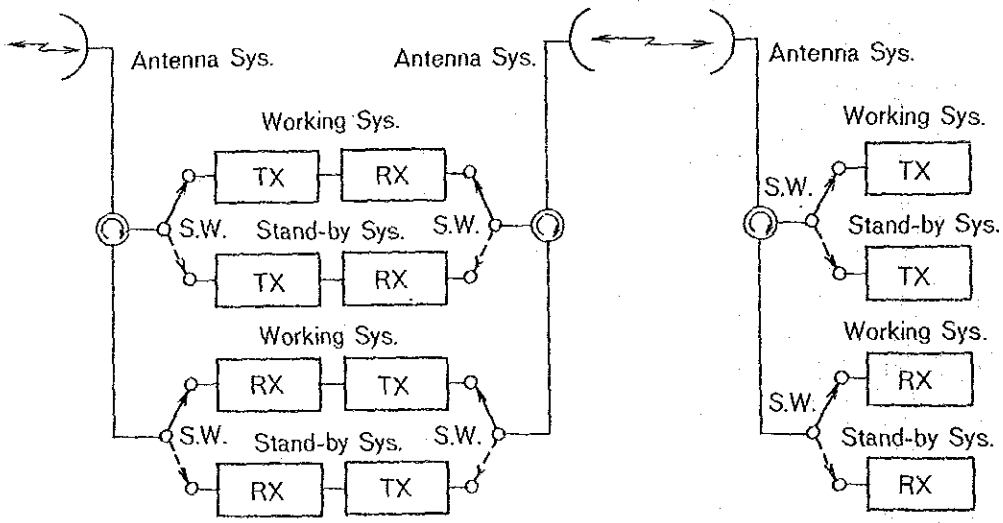


FIG. 2 - 1	LEASED LINE FOR TELEMETER/DATA COMMUNICATION SYSTEM		

Radio Link for Private Telecom.



Radio Link for Public Telecom.

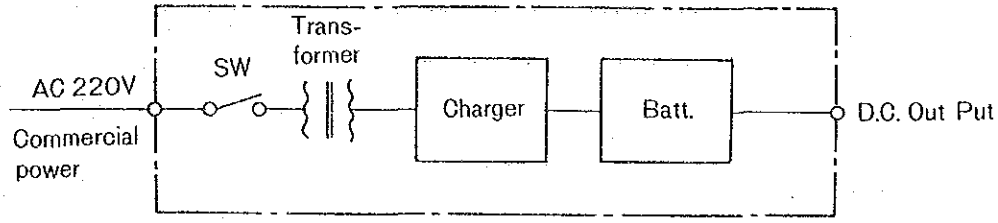


Note

TX : Transmitter
RX : Receiver

FIG. 2 - 2	RADIO LINKS FOR PUBLIC TELECOMMUNICATION AND PRIVATE TELECOMMUNICATION		

Power Supply System for Private Telecom.



Power Supply System for Public Telecom.

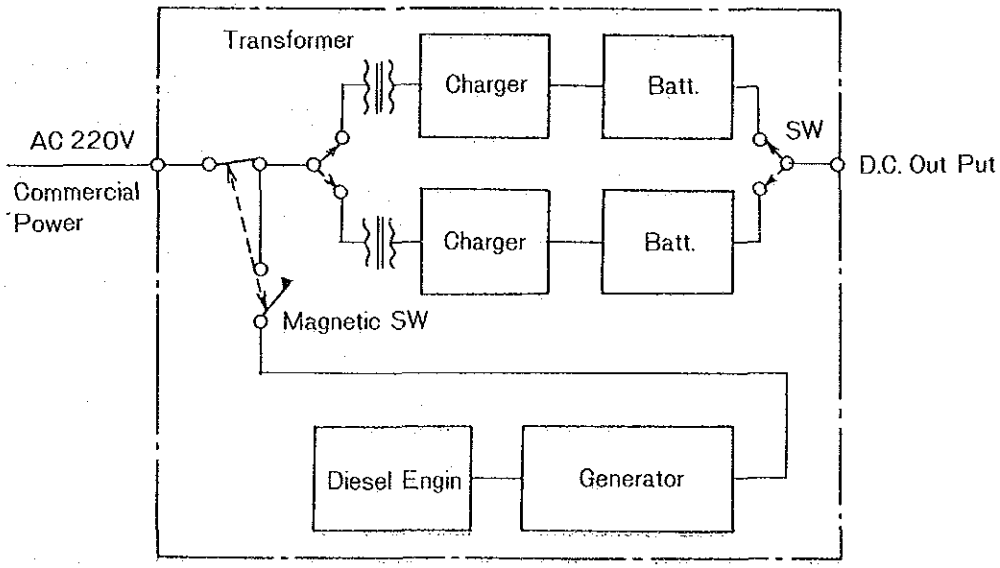


FIG. 2 - 3	POWER SUPPLY SYSTEM FOR PUBLIC TELECOM. AND PRIVATE TELECOM.		

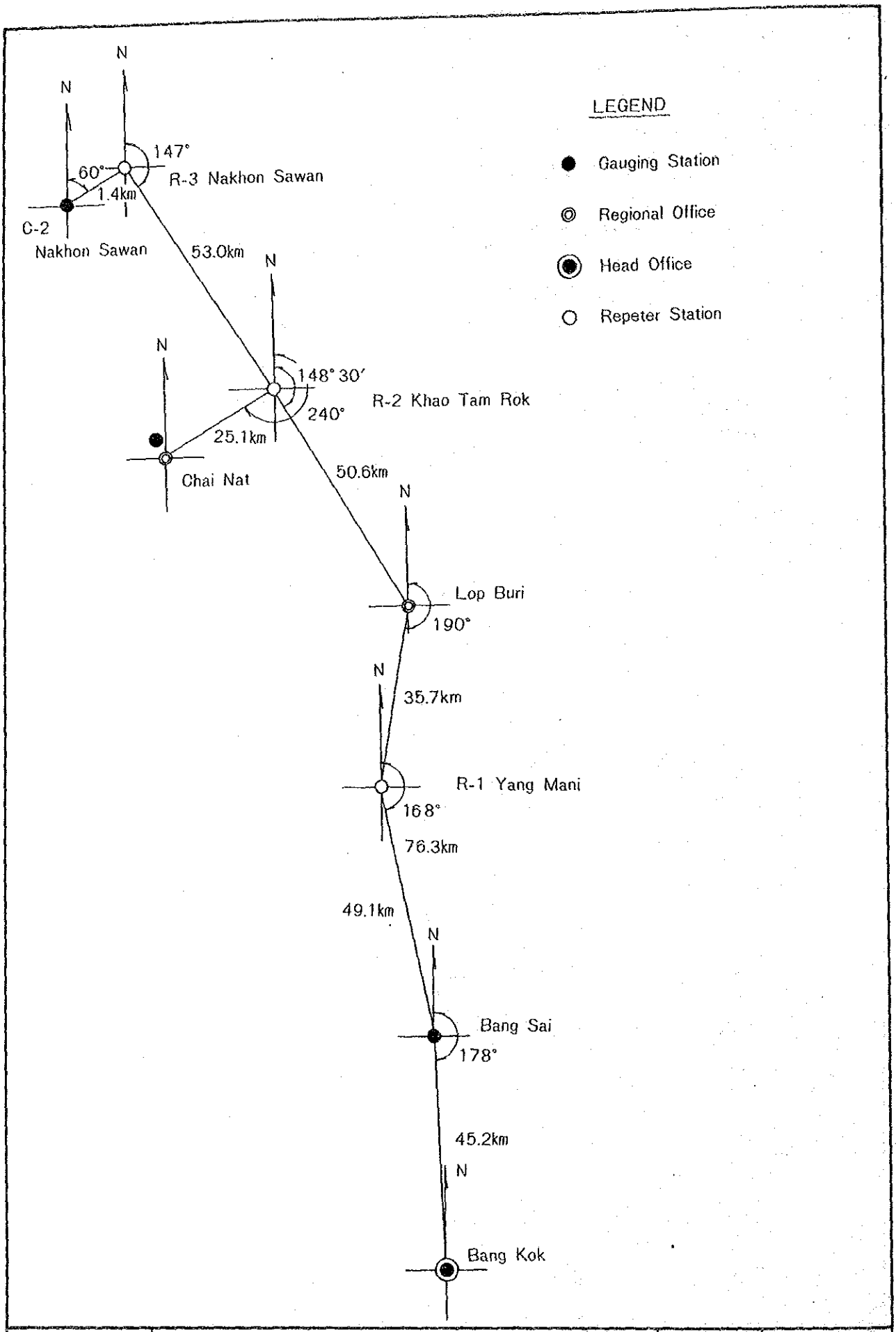


FIG. 2 - 4 ROUTE PLAN FOR RADIO LINK

CHAPTER 3. DESIGN

3-1. TELEMETERING SYSTEM

3-1-1. General Description

The telemetering system to be established under the project is composed master station in IEC building and following gauging stations. Observed data at the gauging stations will be transmitted to the master station through TOT lines and received data by the master station will be displayed and recorded on the computer which will be worked as the control master to the system.

- Nakhon Sawan Gauging Station
- Chai Nat Gauging Station
- Bang Sai Gauging Station
- Memorial Bridge Gauging Station (Bangkok)

The overall system configuration is shown on Fig. 3-1, and location of the master station as well as location of four gauging stations are shown on Fig. 2-1 to Fig. 2-4 in appendix.

3-1-2. Gauging Instrument

The gauging instrument of each station is discussed as follows:

(1) Nakhon Sawan Gauging Station

a) This station has the following two facilities:

- Floating type water level recorder
- Telemark system

The former will be replaced by new one under the project, since it has already superannuated.

b) A new shed will be constructed beside the existing shed to accommodate, the telemeteringing equipment.

c) A tipping bucket rainfall gauge will be installed on the rooftop of existing shelter by taking into consideration of the existing circumstances.

(2) Chai Nat Gauging Station

a) There exist two floating type water level recorders at the up- and downstream of Chao Phraya Dam. However, the water level gauge at the downstream cannot get the accurate record, because it is located at just downstream of the navigation lock out let. Consequently, now pressure type water level gauge will be set at the slope of the river protection at downstream of the dam.

b) A shed will be constructed for the equipment such as analog/digital converter, arrester, etc.

c) A tipping bucket type rainfall gauge will be installed at the existing meteorological field.

(3) Bang Sai Gauging Station

New water level gauging station at Bang Sai will be installed at the immediate downstream from the mouth of the canal close of the Bang Khen regulator at the light bank of the Chao Phraya River. The rain gauge will be positioned on the roof of the shed.

(4) Memorial Bridge Gauging Station

The existing facilities in the C_4 station at the Memorial Bridge are the same as those on Nakhon Sawan Gauging Station. The existing float type water level gauge will be replaced by new one and a tripping bucket rain gauge will be installed on the rooftop of the existing shed.

3-1-3. Telemetering Equipment

(1) Nakhon Sawan/Bang Sai/Memorial Bridge Gauging Station

With the exception of Chai Nat gauging station, both the gauging instrument and telemetering equipment will be installed in the same shed or two sheds located face to face, therefore, there is no need for wiring to have a special arrangement such as provision for under ground cable, arrester, etc.

For Nakhon Sawan, Bang Sai and Memorial Bridge gauging stations, the following equipment will be provided and the system configuration is shown in Fig. 3-2.

- Telemetry Transmitter : 1 set
- Battery Charger : 1 set
- Battery : 1 set

(2) Chai Nat Gauging Station

a) Telemetering equipment including its ancillary equipment for Chai Nat gauging station is listed below and the system configuration is shown in Fig. 3-3.

- Telemetering/Data Communication Equipment : 1 set
- Battery Charger : 1 set
- Battery : 1 set
- Analog/Digital Converter : 1 set
- Arrester : 5 sets

b) Telemetering/Data Communication equipment, battery charger and battery are to be placed at Telemetering/Data Communication room at the second floor of new building of Regional Office VII.

(3) Master Station in IEC

a) The entire telemetering system will be supervised and controlled by the Telemetering/Data Communication equipment which will be

installed at the master station. The telemetering/Data Communication equipment has the following functions:

- To receive the transmitted data from each gauging station, display the data and record on a personal computer at each gauging station basis.

- To give order for sending observed data.

- To cut off data communication automatically with the regional offices and hydrology office, before starting with the regular transmission of data from the gauging stations (refer to Sub-Paragraph 3-3 Data Communication).

- To supervise the entire telemetering system continuously and sound off an alarm when trouble breaks out in the system.

b) The following equipments are to be provided at the master station and the system configuration is shown in Fig. 3-4.

- Telemetering/Data Communication	:	1 set
- Battery Charger	:	1 set
- Battery	:	1 set
- Personal Computer	:	1 set

c) The above-mentioned equipment will be placed in the room where the Water Management Division is located at the second floor of the IEC building.

(4) Recording of the Observed Data

The observed data transmitted from the gauging stations will be recorded on a hand desk of personal computer. This personal computer will be connected with a host computer (VAX) by ethernet, then the data in the host computer file can serve.

3-2. DATA COMMUNICATION SYSTEM

3-2-1. General Description

The data communication system consists of the master station and the following data entry offices.

- Regional Irrigation Office VII (Chai Nat)
- Regional Irrigation Office VIII (Lop Buri)
- Central Hydrology Office (Chai Nat)

The data from the data entry offices will be transmitted to the master station and recorded onto host computer.

The leased line for the telemetering system will be utilized in this scheme as the transmission line. Although, it is impossible to use this data communication system during at the time the data are being transmitted to different gauging stations. This restriction may not cause any serious impediments judging from the volume of data. The overall system configuration is shown in Fig. 3-1.

3-2-2. Equipment for Master Station

The necessary functions and components of the data communication system are incorporated in the telemetering equipment stated in Sub-Paragraph 3-1-3 Telemetering Equipment. The required additional functions are as follows:

a) to enable communication with the persons stationed at the data entry offices by handset.

b) To supervise the data communication system and give an alarm when trouble breaks out in the system.

c) To enable recognition of whether the leased line is busy or idle.

3-2-3. Equipment for Data Entry Offices

(1) Regional Irrigation Office VII

Required functions and electronic elements for the data communication system will be added to the Telemetering/Data Communication Equipment stated in Chapter 3, Paragraph 3-1.

a) To enable communication with the persons stationed at the master station by handset.

b) To send data to the master station by using personal computer.

c) To enable recognition of whether the leased line is busy or idle.

d) The system configuration is given in Fig. 3-4.

(2) Central Hydrology Office

For easy operation of the system an operating console having the following functions will be placed in the Data Communication room of Central Hydrology Office.

a) To enable communication with the persons stationed at the master station by handset.

b) To send data to the master station by using personal computer.

c) To enable recognition of whether the leased line is busy or idle.

d) The system configuration is shown in Fig. 3-3.

(3) Regional Irrigation Office VIII

a) To send data to the master station by using personal computer which will be provided in Data Communication room of the Regional Irrigation Office VIII.

b) The system configuration is shown in Fig. 3-3.

3-3. COMPUTER SYSTEM FOR WATER MANAGEMENT

3-3-1. General

Configuration of computer systems for water management is shown in Fig. 3-6.

The system consists of the following two parts.

- Computer system for Head Office (IEC as host station)
- Computer system for remote stations

The system will be introduced to improve the present water management activities of the RID. To realize the above-mentioned objective, telemetering/data communication system will be established between IEC and each remote station by TOT leased line.

After establishment of the entire system, various important data will be sent to the master station from each remote station through the telemetering/ data communication system. Consequently a host computer system with capabilities listed below will be installed at the master station.

- To store the data received from remote station.
- To enable the data communication between IEC and remote offices which are located Chai Nat and Lop Buri.

After receiving various data, they will be processed to support water management activities. Data processing for water management needs a high

speed processor, to cope up with the huge volume of data and frequent scientific analysis. A Engineering Work Station (EWS) will be introduced to meet the above-mentioned requirements.

Graphic data processing for water management shall be done by EWS. To support the presentation of graphic data to be processed visually, a video projector system will be connected to the EWS.

3-3-2. Host Computer System

The host computer system will be installed at the Water Management Division of IEC as a host processor for the entire system. The main roles of the host computer system are defined as follows.

- To be a control tower for Water Management System.
- To establish the Water Management Database.
- To make a network between existing computer system in the IEC.

The following factor were taken into consideration in the designing the of capacity of the host computer.

- Number of terminals and personal computers to be connected to the host processor.
- Data volume to be stored.
- Contents of data processing.

(1) Number of Terminals and Personal Computers

Two VT terminals and five PCs will be connected to the host processor. These terminals and PCs have the capability for data communication, data entry, program development etc.

(2) Data Volume to be Stored

The data are classified into the following categories.

- Data sent through Telemetering system
- Data sent by data communication

- Water management database
- Source module to be developed at head office
- Load module to be made at head office

Assumption is made an avoidably due to difficulty to grasp concrete data volume.

a) Telemetering System

The data sent by Telemetering system consists of the following items.

- Station code	:	3 Bytes
- Data	:	8 Bytes
- Time	:	4 Bytes
- Water level	:	6 Bytes with a decimal point
- Rainfall	:	5 Bytes

The total data length at a time is 26 Bytes. Two sets of water level gauges will be set at Chao Phraya Dam, and the data length at the Chai Nat station is 32 Byte. If the interval of data sending is set at 3 hours, the total data volume in a day is calculated as follows individually.

- Nakhon Sawan, Bang Sai, Memorial Bridge
  26 Bytes × 8 time = 208 Bytes/day
- Chai Nat
  32 Bytes × 8 time = 256 Bytes/day

Consequently, the total data volume in a year is calculated as follows.

$208 \times 365 \times 3 + 256 \times 365 \times 1 =$ 321,200 Bytes
321.2 KBs/year

The efficiency of filling of a computer system is assumed as one-third generally, required file capacity can be assumed as follows.
To grasp the final file capacity, the using period of this systems is assumed to be 5 years. Consequently, the total required capacity for the Telemetering systems is estimated at follows.

963.6 KB × 5 = 4,818 KB = 4.818 KB
≒ 5 MB

b) Data Communication System

The following data are sent to IEC by data communication system from remote stations.

	Region VII	Hydrology Office	Region VIII
Water Level	○	○	○
Discharge	○	○	○
Rainfall	○	○	○
Cropping Area	○	-	○

The formula sheets for data entry with the use of data communication system will be made during the period of technical cooperation, the data volume to be sent from remote stations are estimated on the basis of present data entry form through vice communication.

According to the present data collection procedure and data entry procedure, the data volume at each office are summarized as follows.

Office	Item	Station Number	Data Volume
Region VII	Water level & discharge	118	3,068 Bytes
	Rainfall	109	1,308
	Cropping Area	44	10,032
	Text		1,000
Region VIII	Water level &	15	
	Discharge	6	3,848
	Rainfall	6	1,428
	Cropping Area	33 Blocks	7,542
	Text		1,000
Central Hydrology Office	Water level	15	300
	Discharge	6	72
	Rainfall	6	60
	Text		1,000

Note: (1) Water level, discharge, rainfall data and text are sent once a day.
(2) Cropping area data are sent once a week.

Consequently, the total data volume from the data communication system are estimated as follows.

	Daily Basis	Weekly Basis
Region VII	5,376 Bytes	10,032 Bytes
Region VIII	6,276	7,524
Hydrology Office	1,432	-
Total	13,084 Bytes	17,556 Bytes

The data volume stored through the data communication system in a year is then estimated as follows.

13,084 Bytes × 365 day = 4,775,660 Bytes
17,556 × 52 week = 912,912
5,688,572 Bytes
≒6 MB/year

After the establishment of the new data communication system, the volume of the data communication is assumed to increase more than when the existing system is in the operation. Especially, on the daily basis, data is expected to increase since the data are sent once a day frequent inspection and observation in a day on the water level and meteorological observation. Therefore, the total data volume of data transmitted can be estimated as follows.

$$6\ \text{MB} \times 1.5 = 9\ \text{MB/year}$$

To understand the final data volume of data communication, assuming the computer will be used for 5 years, the estimation of the total required capacity for data communication is given below.

$$9\ \text{MB/year} \times 5\ \text{years} = 45\ \text{MB}$$

c) Water Management Database

The creation of a water management data base is one of the plans in the IEC Project Phase II. The data base will be contain results of the studies conducted by the Thai and the Japan. Meanwhole, the IEC is keeping a hydrological database that was parpared during the IEC Project Phase I. Its total capacity is 234MB which is stored in the existing computer system.

However, hydrological database presents a limited compared with water management database as follows ;

Hydrological database	:	Water level Discharge volume Rainfall
Water management database	:	Water level · Reservoir · River · Canal Discharge volume · River · Canal Cropping pattern Cropping area Water requirement Water demand Gate control

Therefore, the total volume of the water management database will be increased more than 234 MB. To determine the capacity of the water management database, the final capacity is assumed as 300 MB.

d) Source Module

To support the routine work for data processing, various kind of software will be developed by the host computer system. In the operation of the computer system, the Operating System (OS), Database Management System (DBMS) and the compiler are needed.

The operating systems of VAX system are named as VAX/VMS. These basic software occupy a disk unit of 209 MB. It is very difficult in grasping the volume of the source module, because its number will be increased year by year. At the initial stage, the total capacity of sources module is assumed as 50 MB based on past experience.

e) Load Module

To execute the application software, a load module shall be made by the language compiler. Generally, the capacity of a load module is bigger than the capacity of the source module after processed by the compiler. On the other hand, it does not always follow that the load module is made for all of the source modules. Therefore, the total capacity of the load module is assumed to be 50 MB.

f) Total Volume

The data volume to be stored in the disk unit is summarized as follows.

· Telemetering System	5 MB
· Data communication System	45 MB
· Water Management Database	250 MB
· Source Module	50 MB
· Load Module	50 MB
· Operating System	210 MB
	610 MB

(3) Main Memory Capacity

The memory capacity of the computer system is defined as following factor.

- Operating System
- Number of Terminals
- Number of Batch Jobs
- Database Management System

a) Operating System

The operating system is an essential software to control the entire system of the host computer. The computer system of IEC has been using the VAX computer system since IEC Project Phase I. Since the compatibility of the present computer system and newly system is most important factor to keep the high performance of the net work

system, same operating system will be adapted to the new host processor.

Consequently, VAX/VMS will be installed as a operating system for a host processor. At least, VAX/VMS requires 4 MB in the main memory.

b) Number of Terminals

After establishment of entire system for the Water Management Center, following terminals and PCs will be connected with host processor.

- VT Terminal	1 set × 1 MB
- Personal Computer	3 set × 1 MB
- EWS	1 set × 2 MB
Total	6 MB

c) Number of Batch Jobs

Generally, a big capacity job is executed under background of the CPU. The required capacity depends on the size of batch job and number of batch jobs. The required capacity is assumed 2 MB in minimum scale of the job.

d) Database Management System

Database Management System (DBMS) will be installed to establish the Water Management Database System. Required capacity for the DBMS is assumed to be 4 MB in the main memory.

e) Total Memory Capacity

Total memory capacity is summarized as follows.

Operating System	4 MB
Number of Terminals	6 〃
Number of Batch Jobs	2 〃
Database Management System	4 〃
Total	16MB

3-3-3. Engineering Workstation System

In policy making of water management, decision makers need various kinds of data processed by the computer. This data processing procedure should be done quickly for alternative study with actual data processing and graphic processing for visual judgment.

At present, when estimating water requirement and making water distribution plan make, the figures and graphs required are done manually.

To improve on this practice, the Engineering Workstation (EWS) will be installed making it possible to accomplish it objective quickly, accurately and collectively. Therefore, an Engineering Workstation (EWS) is to be installed to realize the above mentioned requirement.

The data processing unit for the water management is required to be capable of:

- Handling the big volume data immediately.
- Executing scientific and statistic analysis.
- Computer graphics.

To realize the above-mentioned requirements, a high speed CPU and a large main memory are required. An EWS is suitable for high speed and large capacity data processing.

(1) Data Volume to be Stored

Data volume are classified into following items.

- Data for estimation of water requirement
- Data for estimation of water distribution

- Data for graphic presentation system
- Source module
- Load module

The above-mentioned items are similar to items of a host computer system. Though, at this point, it is very hard to come out with estimations of the data volume, following is an assumption of total volume.

a) Data for Estimation

To estimate the water requirement and water distribution, a great number of data items are necessary. For example, to estimate the water requirement, amount of the consumptive use for each crops, effective rainfall for each area and irrigation efficiency on a weekly or daily base.

Supposing each data will need 100 MB, total volume can be assumed as 300 MB.

b) Source Module and Load Module

VAX/VMS will also be installed in the EWS for the operating system. It occupies 200 MB the same as the host processor. Additionally, the source module and load module shall be stored in the EWS for the data processing of water management. It is assumed to need 100 MB.

c) Total Volume

The total data volume to be stored in the disk unit are summarized as follows.

- Data for estimation	300 MB
- Operating System	200 MB
- Source Module and Load Module	100 MB
	600 MB

(2) Main Memory Capacity

The memory capacity of EWS is defined as follows factor.

- Operating System
- Work area for graphic processing
- Number of batch job
- Work area for data processing

a) Operating System

VAX/VMS will be adopted as the operating system for the EWS. The required capacity of VAX/VMS is the same as the host processor. VAX/VMS requires 4 MB in the main memory.

b) Work Area for Graphic Processing

VAX GKS (Graphic Kernel System) will be installed to execute graphic data processing under the EWS. To operate the graphic application software which is developed by VAX GKS, it will occupy 2 MB for work area in main memory.

c) Number of Batch Jobs

A big capacity job is executed under background of the EWS. The required capacity depends on the size of the job, and in this stage the capacity is assumed to be 4 MB in a conservative estimate.

d) Work Area for Data Processing

Since almost all of the data processing of the EWS is executed under the interactive mode through the monitor screen of the CPU, the resources of the memory are required plentifully. To keep the quick response, plenty of files are loaded on the memory. Therefore, memory space of 4 MB is prepared for the foreground processing.

e) Total Memory Capacity

The total memory capacity is summarized as follows.

-	Operating System	4 MB
-	Work area for Graphic Processing	2 MB
-	Number of Batch Job	4 MB
-	Database Management System	4 MB
		14 MB

3-3-4. Presentation System

(1) Video Projector System

The processing of data to support the daily routine work for water management will be done mainly on the EWS. In consolidating the processed data, the graphical resources by computer system should be established. On the new system the result analysis can be displayed on the monitor in various kinds of figures and tables.

Up to now the result of analysis by the computer has been printed on the papers plentifully. But in the procedure of the water management activities, the result of the analysis is not target in the job. The policy makers require the various kinds of figures and tables to make a decision for the water distribution plan. For making conclusion, visual judgment is very use full way.

The other hand, the interface between user and EWS is a monitor. The weak point of the system is monitor size. The policy makers can not share the small monitor in same time in the meeting. To support the water management activities, many kinds of figures and table will be developed under the EWS in the further plan. It is not a reasonable way to make many graphic panel one by one. Here is a reason to introduce the video projector system to resolve above-mentioned problem. This is a advanced technology as unity of computer and video projector system.

The figures and tables will be displayed on the big size screen through the projector from EWS. The screen will be set sized 100 inches on the wall. Since the result of various kinds of graphic data processing by the EWS can be presented to many number of persons concerned in a moment, the effect of the improvement will be increased greatly.

(2) Graphic Panel

A graphic panel was installed at the conference room of O & M Division in RID to supports the water management activities regarding the delta area of Chao Phraya River. This panel was installed as a pilot system of the improvable method for the water management procedure by JICA, during the study of Master Plan for the Chao Phraya River Basin. Therefore, the system was established simply as mentioned below.

- Personal computer ..... entry the water level and discharge dater which are sent from remote station.
- Graphic panel ..... display the entered data through the personal computer.

This system is independent of the existing computer system of IEC. because of the pilot system, and the function is limited to enlarge the data, and entered on the board. In this phase, it is one of the main theme to consider the existing graphic panel in the future plan. After surveying the existing graphic panel at first stage by the study team, following items were found out.

- The existing graphic panel has been out of order since beginning of 1990.

- The reason of the trouble is not still clear and RID didn't provide any kind of means to resolve the trouble.

The joint works were carried out by RID and Study Team to find out the reason, and the following items were pointed out by both sides.

- Electric system is available.

- Data entry system and display system, which are the part of entire system recorded in the personal computer, are alive.

- The displayed value on the monitor is not indicated on the graphic panel.

- To diagnose the present status on the interface and connector between the personal computer and graphic panel, the expert of computer electric system should be sent to RID.

- The control software of the centric system has been not modified.

The study team requested NEC Engineering Co., Ltd., to fin out the cause of trouble and report to RID regarding work plan for the recovery of the system.

On the other hand, RID requested the following plan to improve the existing graphic panel.

- River water level data, which are sent from four remote stations of the Telemetering system, shall be displayed on the existing graphic panel in real time.

After consideration by the technical cooperation team and study team, the following technical views were pointed out to RID.

- To realize the request of RID, a large scale work for improvement should be need.

  - Because the existing system is stand alone system, it should be connected with newly computer net work system.

  - Additional indicators should be put on the graphic panel.

  - Existing computer software for the graphic panel system should be modified drastically.

After renovation, the new graphic panel can display the four value of the water level out of fourty-nine stations. It is not so much different with present function of graphic panel. Additionally, present graphic panel can display only water level and discharge volume of each stations, it has not expansibility.

Consequently, it is better to consider about installation of newly presentation system than renovation plan of existing graphic panel, from aspect of cost performance. The technical views of the Study Team was accepted by RID. After recovery of the existing graphic panel, it will be transferred to IEC, leaving the matter as it is.

TABLE 3-1 EQUIPMENT LIST

1. IRRIGATION ENGINEERING CENTER

1-1 TELEMETERING MASTER STATION

*	Telemeter/Data Communication Equipment	1 lot
*	Battery and Battery Charger	1 lot
*	Personal Computer	1 lot
*	Printer	1 lot
*	MODEM	2 units

1-2 COMPUTER SYSTEM

a) Water Management Division

*	Host Computer (VAX)	1 lot
*	Terminal	2 lots
*	Leaser Printer	1 lot
*	Digitizer	1 lot
*	Engineering Workstation	1 lot
*	Image Printer	1 lot
*	UPS	2 units
*	Desk	7 units
*	Chair	4 units

b) Hydrological Research and Application Division

*	Personal Computer	1 lot
*	Printer	1 lot
*	Plotter	1 lot
*	Digitizer	1 lot
*	UPS	1 unit
*	Desk	4 units
*	Chair	2 units

1-3 VIDIO PROJECTOR SYSTEM

*	Video Projector	1 lot
*	Screen	1 lot
*	Video Cassette Player	1 lot

2. NAKHON SAWAN GAUGING STATION

* Float Type Water Level Gauge with Recorder ..... 1 lot
* Rain Fall Gauge with Recorder ..... 1 lot
* Telemetering Remote Equipment ..... 1 lot
* Terminal ..... 1 lot
* Battery and Battery Charger ..... 1 lot

3. CHAI NAT

3-1 REGIONAL IRRIGATION OFFICE

* Personal Computer ..... 1 lot
* Printer ..... 1 lot
* Modem ..... 1 lot
* UPS ..... 1 lot
* Telemeter/Data Communication Equipment ..... 1 lot
* Terminal ..... 1 lot
* Battery and Battery Charger ..... 1 lot
* Desk ..... 3 units
* Chair 1units

3-2 CENTRAL HYDROGY OFFICE

* Personal Computer ..... 1 lot
* Printer ..... 1 lot
* Modem ..... 1 lot
* UPS ..... 1 lot
* Operation console ..... 1 unit
* Desk ..... 3 units
* Chair ..... 1 unit

3-3 CHAI NAT GAUGING STATION

* Analog/digital Convertor ..... 1 unit
* Pressure Type Water Level Gauge ..... 1 unit
* Rain Fall Gauge with Recorder ..... 1 unit
* Cable Protector ..... 5 units
* Cable ..... 1 lot

4. REGIONAL IRRIGATION OFFICE 8

* Personal Computer ..... 1 lot
* Printer ..... 1 lot

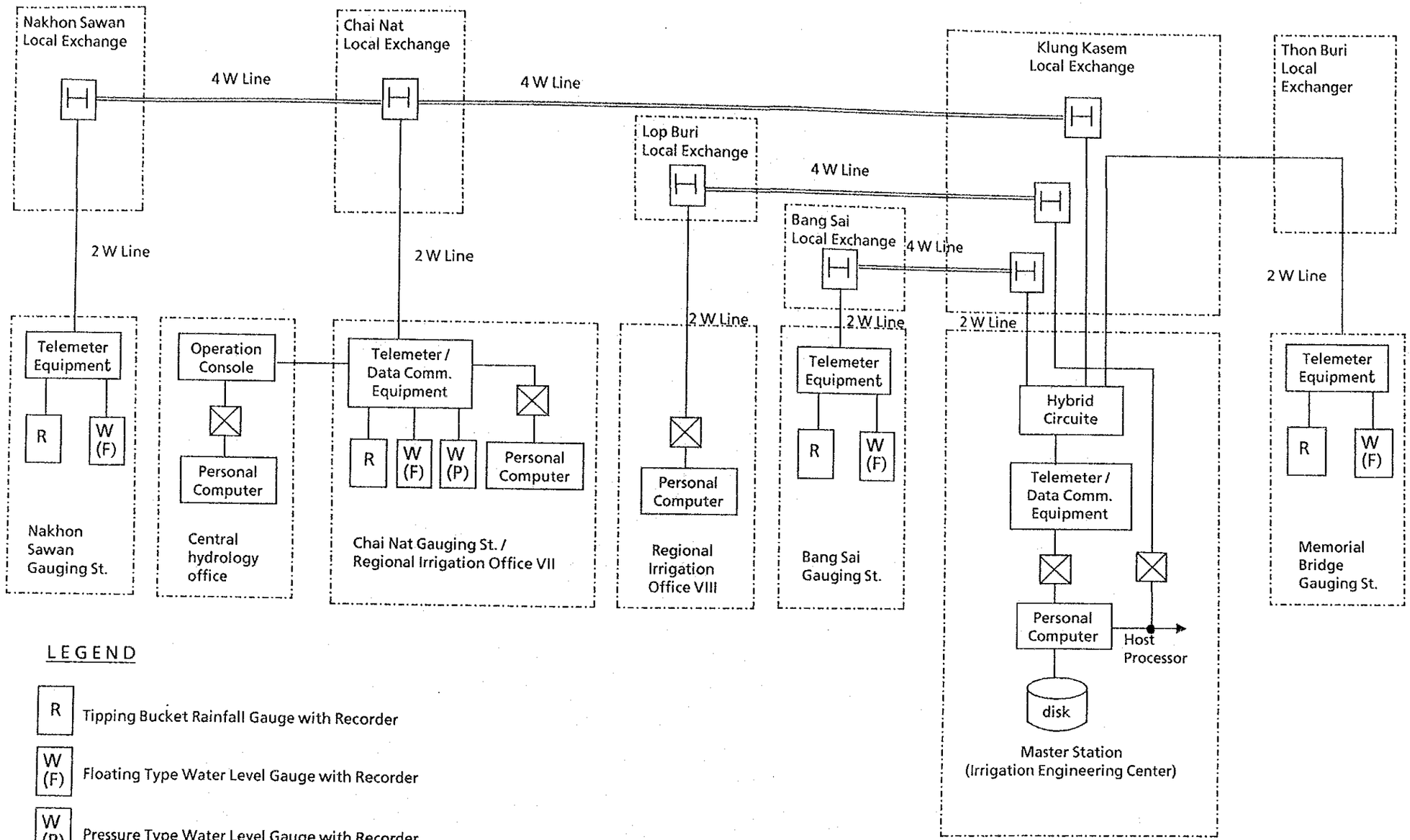
* Modem ..... 1 lot
* UPS ..... 1 lot
* Desk ..... 3 units
* Chair ..... 1 unit

5. BANG SAI GAUGING STATION

* Float Type Water Level Gauge with Recorder ..... 1 lot
* Rain Fall Gauge with Recorder ..... 1 lot
* Telemetering Remote ..... 1 lot
* Terminal ..... 1 lot
* Battery and Battery Charger ..... 1 lot

6. MEMORIAL BRIDGE GAUGING STATION

* Float Type Water Level Gauge with Recorder ..... 1 lot
* Rain Fall Gauge with Recorder ..... 1 lot
* Telemetering Remote l ..... 1 lot
* Terminal ..... 1 lot
* Battery and Battery Charger ..... 1 lot



LEGEND

R	Tipping Bucket Rainfall Gauge with Recorder
W (F)	Floating Type Water Level Gauge with Recorder
W (P)	Pressure Type Water Level Gauge with Recorder
⊠	MODEM

FIG. 3 - 1		
OVERALL SYSTEM CONFIGURATION FOR TELEMETER / DATA COMMUNICATION		

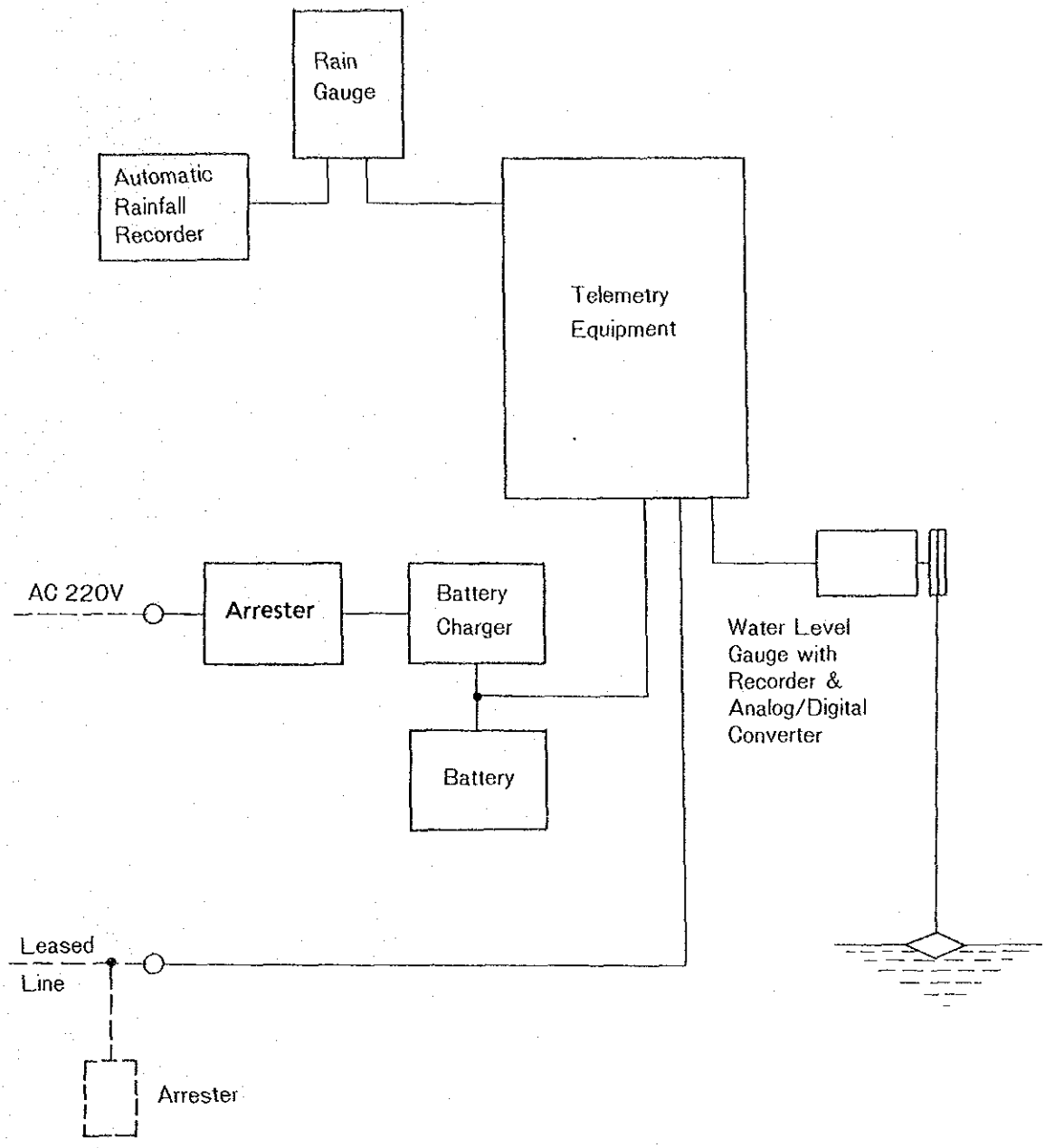


FIG. 3 - 2	SYSTEM CONFIGURATION OF NAKHON SAWAN, BANG SAI AND MEMORIAL BRIDGE GAUGING STA.		

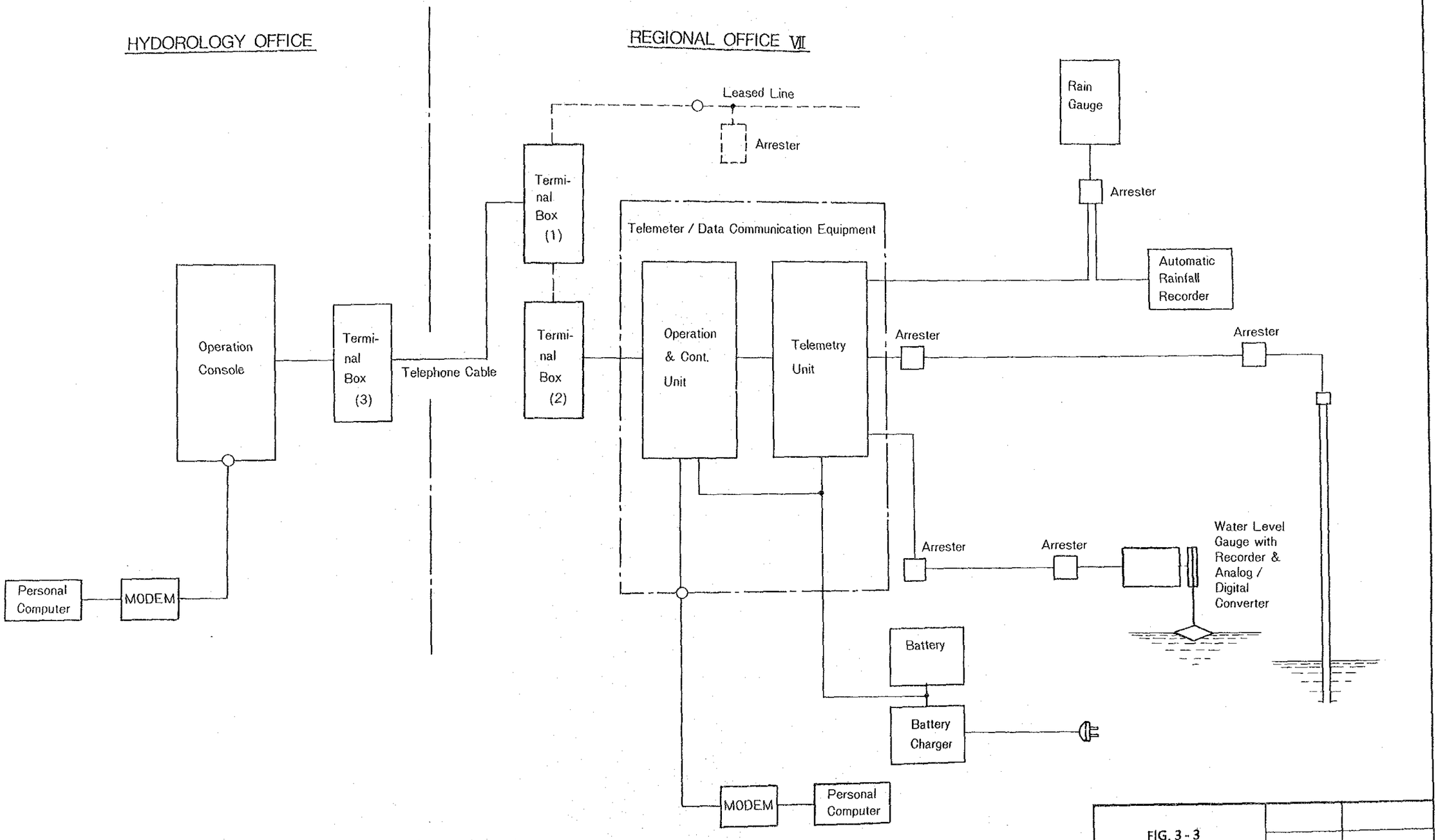


FIG. 3 - 3

SYSTEM CONFIGURATION OF CHAI NAT GAUGING STA., REGIONAL IRRIGATION OFFICE VII AND CENTRAL HYDROLOGY OFFICE

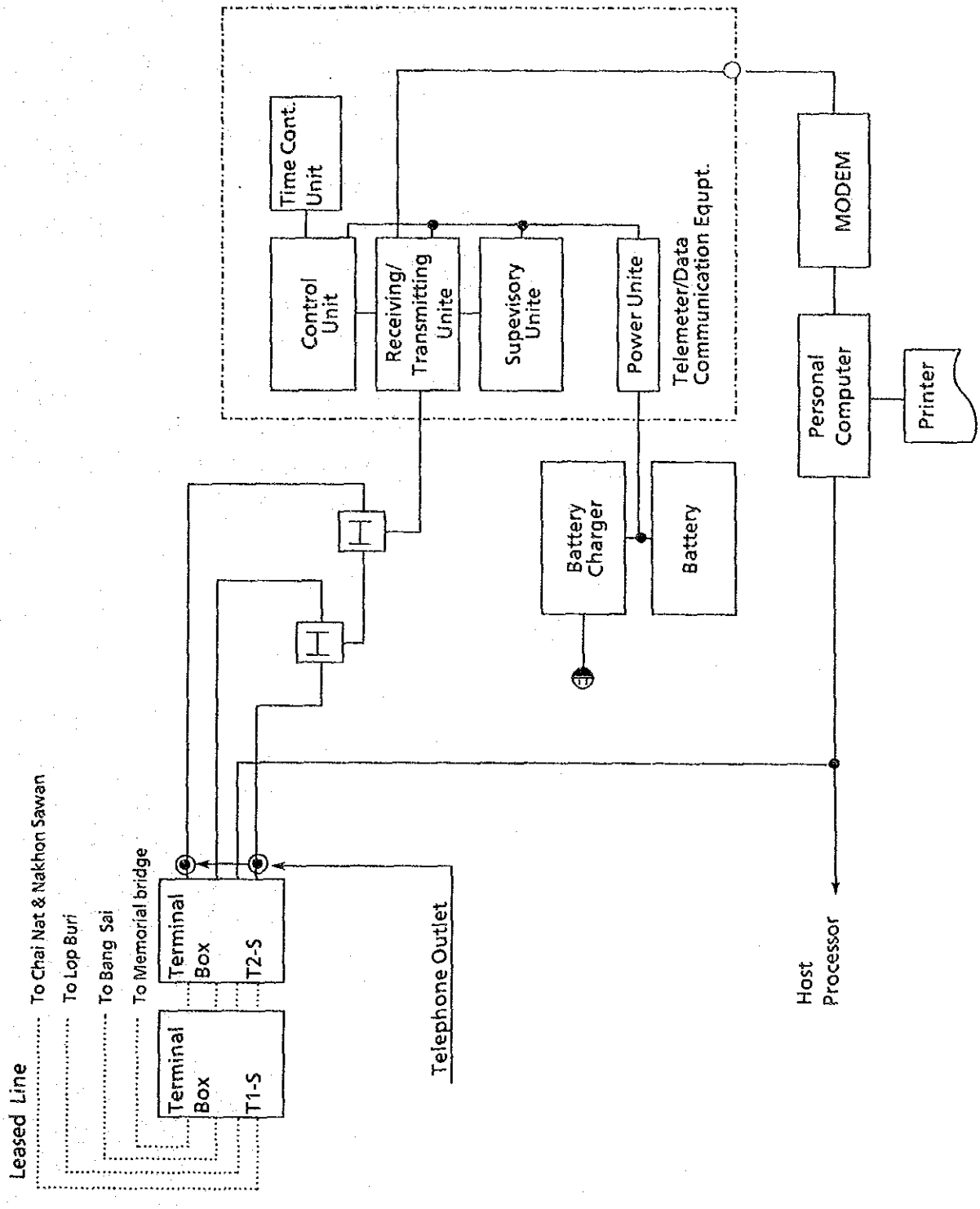


FIG. 3-4 SYSTEM CONFIGURATION OF MASTER STATION (IEC)

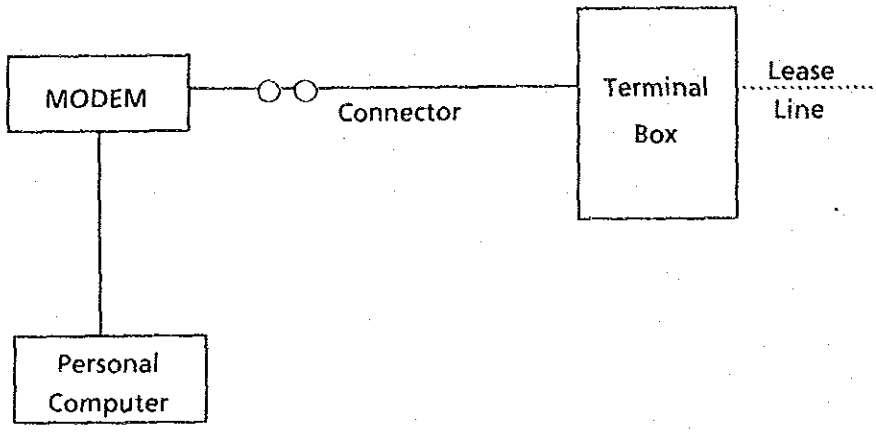


FIG. 3 - 5	SYSTEM CONFIGURATION OF REGIONAL IRRIGATION OFFICE Ⅷ		

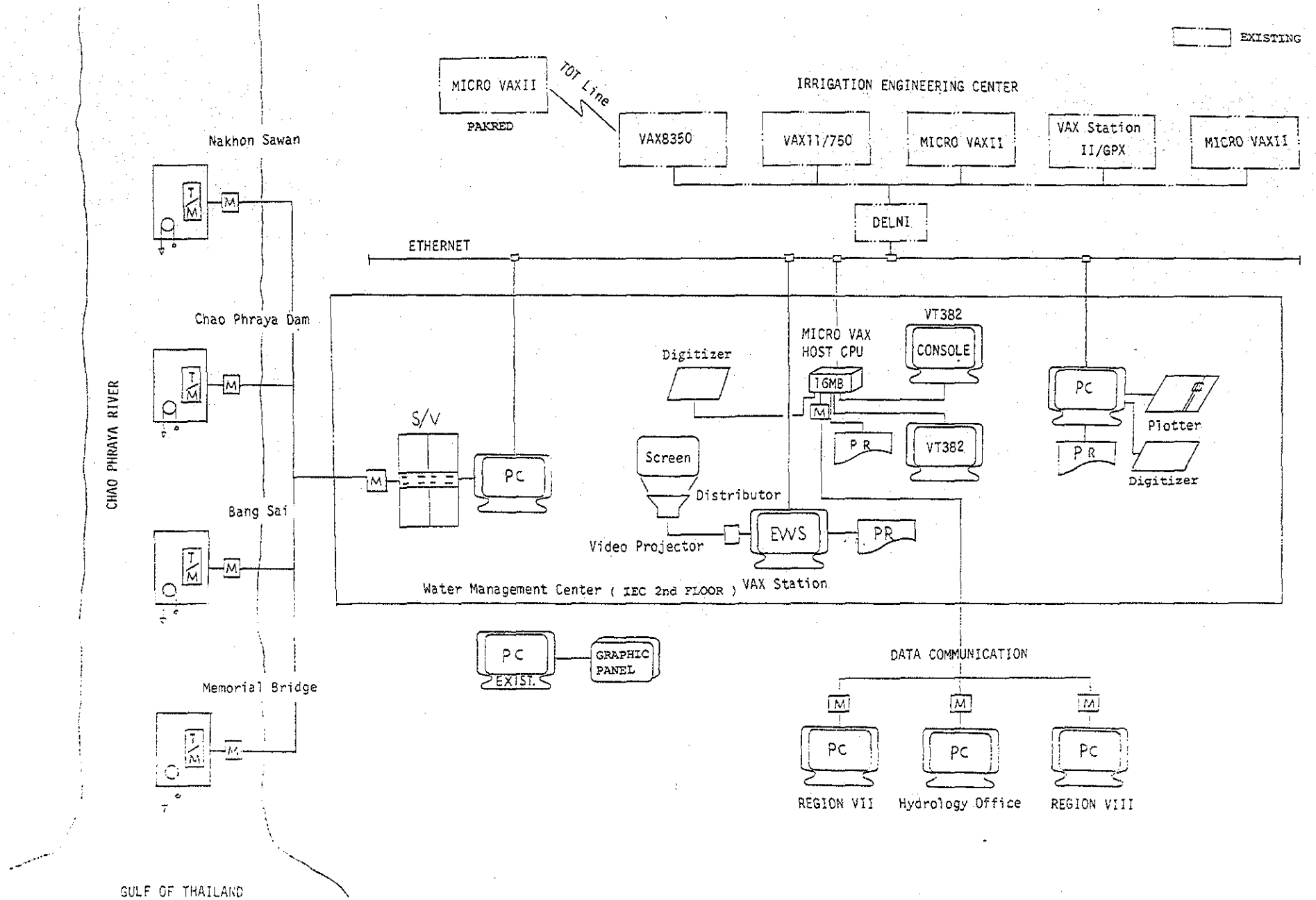


FIG. 3-6 TELEMETER AND DATA COMMUNICATION SYSTEM CONFIGURATION

CHAPTER 4. IMPLEMENTATION PLAN

4-1. IMPLEMENTATION METHOD

The scope of the Project is the procurement of equipment and construction of related facilities such as Telemetering/Data Communication System. The contract for the service and procurement of equipment will be made by following three manners, because these works are not fit to execute under one contract.

* Contract 1 ..... Supply of Telemetering/Data Communication System
* Contract 2 ..... Construction of Facilities
* Contract 3 ..... Procurement of Equipment for Computer, Video Projector and so on.

Contract 1 and Contract 2 will be carried out by full contracts with the firms or companies registered in Thailand, and Contract 3 will be procured by items.

The equipment for Telemetering/Data Communication System, Computer Video Projector, etc. will be imported.

4-2. IMPLEMENTATION SCHEDULE

Table 4-1 shows the tentative implementation schedule based on the same date delivery of bid documents to the bidders and same day of bid document delivery. It is not necessary to start the bidding at same day, however, construction works under Contract 2 shall be arranged to complete before installation of telemeteringing system. For smooth implementation of the works, following bidding procedure is proposed.

① To finalize the work schedule under contract 1 with contractor immediately after contract.

② To arrange the bidding schedule 2 to fit the work schedule under contract 1.

③ To carry out the bidding and contracting by the bidding schedule.

As shown on the Table 4-1, bidding period will be four weeks for Contract 1 and two weeks for Contract 2 and Contract 3. Custom clearance period is estimated for six weeks, because the documentation for free custom clearance for importation of equipment can be started after arrival of Bill of Lading, invoice, etc.

Video Projector will be used for the presentation of results of the EWS. Procurement of video projector will not be procured before purchasing of EWS, beside, other computer equipment may be procured independently.

It is scheduled for 2.5 months of bidding supervision and one month of inspection works on Contract 1 and Contract 2 as shown on Table 4-1, however no supervision will be considered for Contract 3.

TABLE 4-1 TENTATIVE IMPLEMENTATION SCHEDULE

Description \ month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
BIDDING 1															
DELIVERY OF B/D	△														
BID OPEN		△													
CONTRACTING		△													
MANUFACTURERING		═══	═══	═══	═══	═══	═══	═══							
TRANSPORTATION								═══	═══						
CUSTUM CLEARANCE									═══	═══					
INSTALLATION											═══	═══			
INSPECTION												═══			
BIDDING 2															
DELIVERY OF B/D	△														
BID OPEN	△														
CONTRACTING		△													
CONSTRUCTION		═══	═══	═══	═══										
INSPECTION					═══										
BIDDING 3															
DELIVERY OF B/D	△														
BID OPEN	△														
CONTRACTING		△													
MANUFACTURERING		═══	═══	═══	═══	═══									
TRANSPORTATION							═══								
CUSTUM CLEARANCE								═══	═══						
HAND OVER									═══						
SUPERVISOR DUE PERIOD	═══ 2.5m/m				═══ 1.0m/m							═══ 1.0m/m			

CHAPTER 5. COST ESTIMATE

Project Cost was estimated as ¥ 103,821,000.- according to the following manners and the summary of cost estimate is given in Table 5-1.

1) Unit price was applied as of April, 1991.

2) Currency exchange rate was used

1 Baht = ¥ 5.45

1 US$ = ¥ 138.11

3) Unit price of equipment was decided based on the there quotations as much as possible.

4) Unit of labours and materials are based on the Unit Cost for Construction Project in Irrigation Project prepared by Thai Contractor Association.

TABLE 5-1 COST ESTIMATE

1. Supply and Installation of Telemeter / Data Communication System

	Q'ty	Unit (฿)	Amount (฿)
1-1 Master Station (IEC)			
* Telemeter/Data Communication Equipment	1		561,376
* Personal Computer	1		443,817
* Soft water for the above	1		1,353,230
* Cable & Device to VAX	1		38,862
* Soft ware for the above	1		692,807
* Printer	1		41,413
* Line Switch	1		52,055
* Telephone Unit	1		52,055
Sub-total			3,235,615
1-2 Remote Station			
* Telemeter/Data Communication Equipment	1		524,807
* Telemeter equipment	3	524,807	1,574,421
* Line Switch	4	52,064	208,256
* Hybrid	1		52,055
* Float Type water Level Gauge with Recorder	1		292,110
* Rain Fall Gauge with Recorder	4	168,688	674,752
* Telephone Unit	3	52,055	156,165
Sub-total			3,482,566
1-3 Spare Pants	1		1,274,862
Total			7,993,043
Contingency			1,238,957
Grand Total			9,232,000
			(¥ 50,314,000)

2. Construction of Facilities

	Q'ty	Unit (฿)	Amount (฿)
2-1 Construction Cost of IEC			1,055,046
2-2 Construction Cost of Nakhon Sawan Gauging Station			460,630
2-3 Construction cost of Bang Sai Gauging Station			491,791
2-4 Construction Cost of Chai Nat Gauging Station			1,378,274
Sub-Total			3,385,741
Contingency			522,977
Total			3,908,718
			(¥21,300,000)

3. SUPPLY OF COMPUTER, VIDEO PROJECTOR, ETC

	Q'ty	Unit (฿)	Amount (฿)
3-1.Irrigation Engineering Center			
* Host Computer	1		1,114,690
* Console Terminal	1		45,833
* Terminal	1		45,833
* Laser Printer	1		90,000
* Digitizer	1	31,500	63,000
* EWS	1		1,189,320
* EWS Soft	1		917,060
* Image Printer	1		72,300
* DODEM	1		18,500
* Video Projector	1		500,700
* Screen	1		65,000
* Video Cassette Player	1		123,490
* Personal Computer	1		175,000
* Printer	1		33,200
* Plotter	1		46,300
* UPS	3	32,000	96,000
* Desk	11	Procuring by	
* Chair	6	Thai side	
Sub-Total			4,596,220
3-2.Regional Irrigation Office 7&Central Hydrogy Office			
* Personal Computer			
* Printer	2	175,000	350,000
* MODEM	2	33,200	66,400
* UPS	2	18,500	37,000
* Desk	2	32,000	64,000
* Chair	6	Procuring by	
	2	Thai side	
Sub-Total			517,400
3-3.Regional Irrigation Office 8			
* Personal Computer			
* Printer	1		175,000
* MODEM	1		33,200
* UPS	1		18,500
* Desk	1		32,000
* Chair	3	Procuring by	
Sub-Total	1	Thai side	
Total			258,700
Contingency			5,372,320
Grand Total	(10%)		537,232
			5,909,552
Total Project Cost			(¥32,207,000)
		(¥ 103,821,000)	

APPENDIX

JAPAN INTERNATIONAL COOPERATION AGENCY
DETAILED DESIGN SURVEY TEAM
FOR
THE IRRIGATION ENGINEERING CENTER PROJECT PHASE II

April 16,1991

Mr. Kitcha Polparsi
Director of Irrigation Engineering Center

Re. The Telemetering System and Data Communication System for the Irrigation Engineering Center Project Phase II.

Dear Sir,

The detailed Design Survey Team has been organized by Japan International Cooperation Agency (JICA) for the purpose of formulating detailed design on the Telemetering System and Data Communication System (hereinafter referred to as "the System") for the Irrigation Engineering Center Project Phase II.

The Team, so far, made a series of site reconnaissances and discussions with your staff concerned in order to determine the basic plan of the System. As the result, we would like to submit to you the basic plan for the System.

Three team members, Mr. Kondo, Mr. Shimoji and Mr. Komagata, will proceed with your staff to conduct further field surveys and investigations at the site and make the detailed design on the basis of the basic plan. After the completion of the detailed design and cost estimation, the report will be submitted to the Royal Irrigation Department through the JICA Thailand office.

Lastly, we would like to express our appreciation for the kind cooperation of your staff during our stay.

Sincerely Yours,

Yukiharu Harada
Team Leader
Detailed Design Survey Team
Japan International
Cooperation Agency

1. OBJECTIVE

This survey is to carry out the detailed design on the telemetering system and data communication system for the Irrigation Engineering Center Project Phase II.(hereinafter referred to as "the Project")

The telemetering system and data communication system will be a core for the activities of the technical cooperation of the Project.

In the light of the above, the Team conducted the surveys on the selection of the water level gauging stations, terminal stations for data communication system and required computer system in RID Samsen as a control center, and several discussions on the transmission methods for telemetering system and data communication system.

2. LOCATION

(1) The location of water level gauging and rainfall station will be at the following four stations ;

a) Existing C2 gauging station at Nakhon Sawan :
Water level gauging equipment with automatic recorder will be replaced by the same equipped telemetering converter.Existing Telemark system will be remained as the present condition. The rainfall gauging equipment with automatic recorder will be installed in the station.

b) Existing gauging stations at upstream and downstream of Chai Nat Dam:
Telemetering conventer will be installed on the existing water level gauges with automatic recorder.The rainfall gauging equipment will be installed at near the Hydrology office.

c) Bang Sai gauging station :
There is no gauging station at the site, therefore, new water level gauging station will be constructed at the intake mouth of Bang Khen regulator, and new water level gauging equipment with telemetering converter will be installed in it. The rainfall gauging equipment will be installed in the station.

d) Existing C4 gauging station at near the Memorial Bridge: The same as the existing C2 gauging station

(2) Location of terminal station for data communication will be at the following three offices :

a) Main building of Regional Irrigation office 7 in Chai Nat Province.
b) Hydrology office in Chai Nat Province.
c) Main building of Regional Irrigation office 8 in Lop Buri Province.

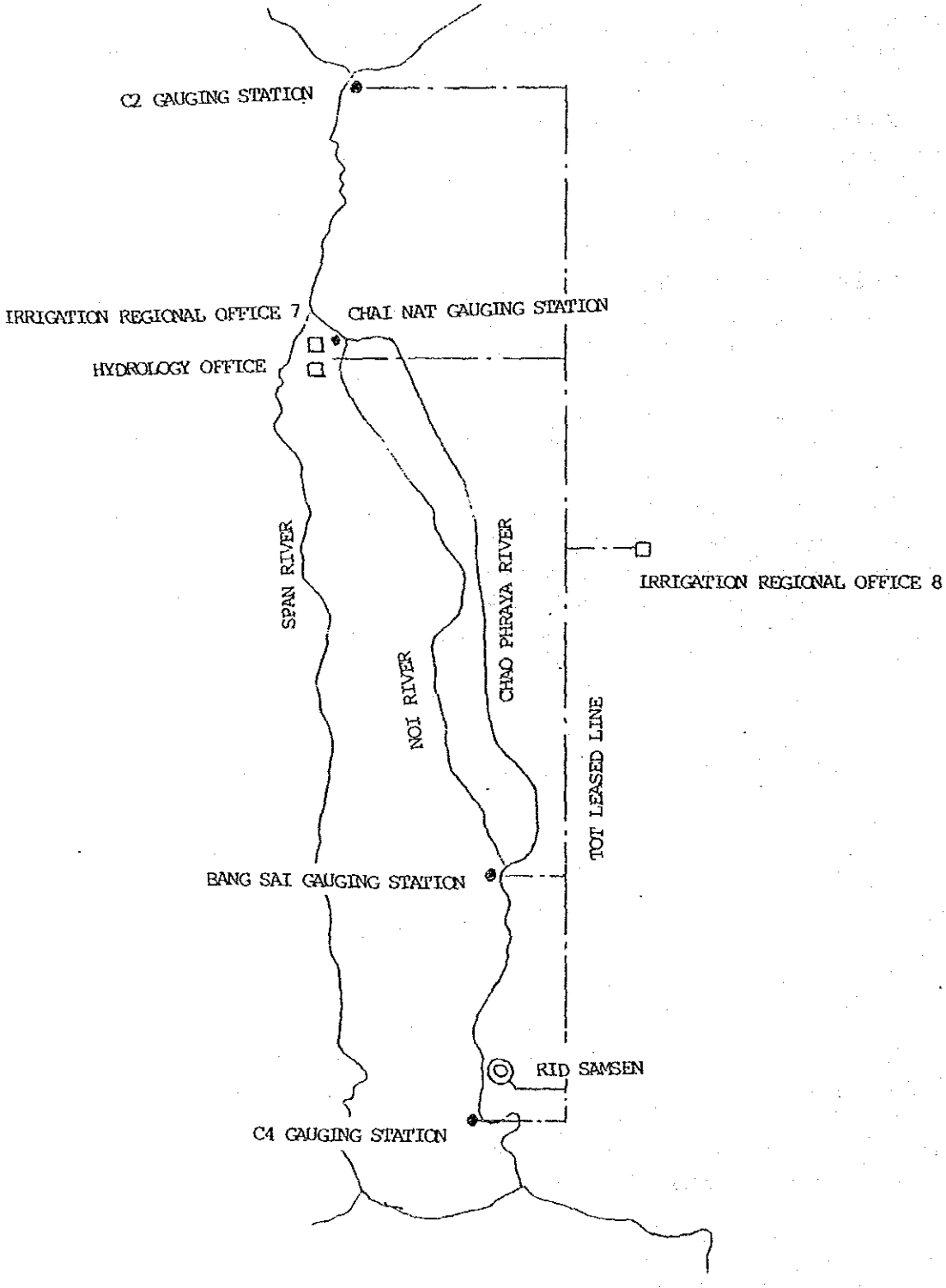
3. COMPONENTS OF THE SYSTEM

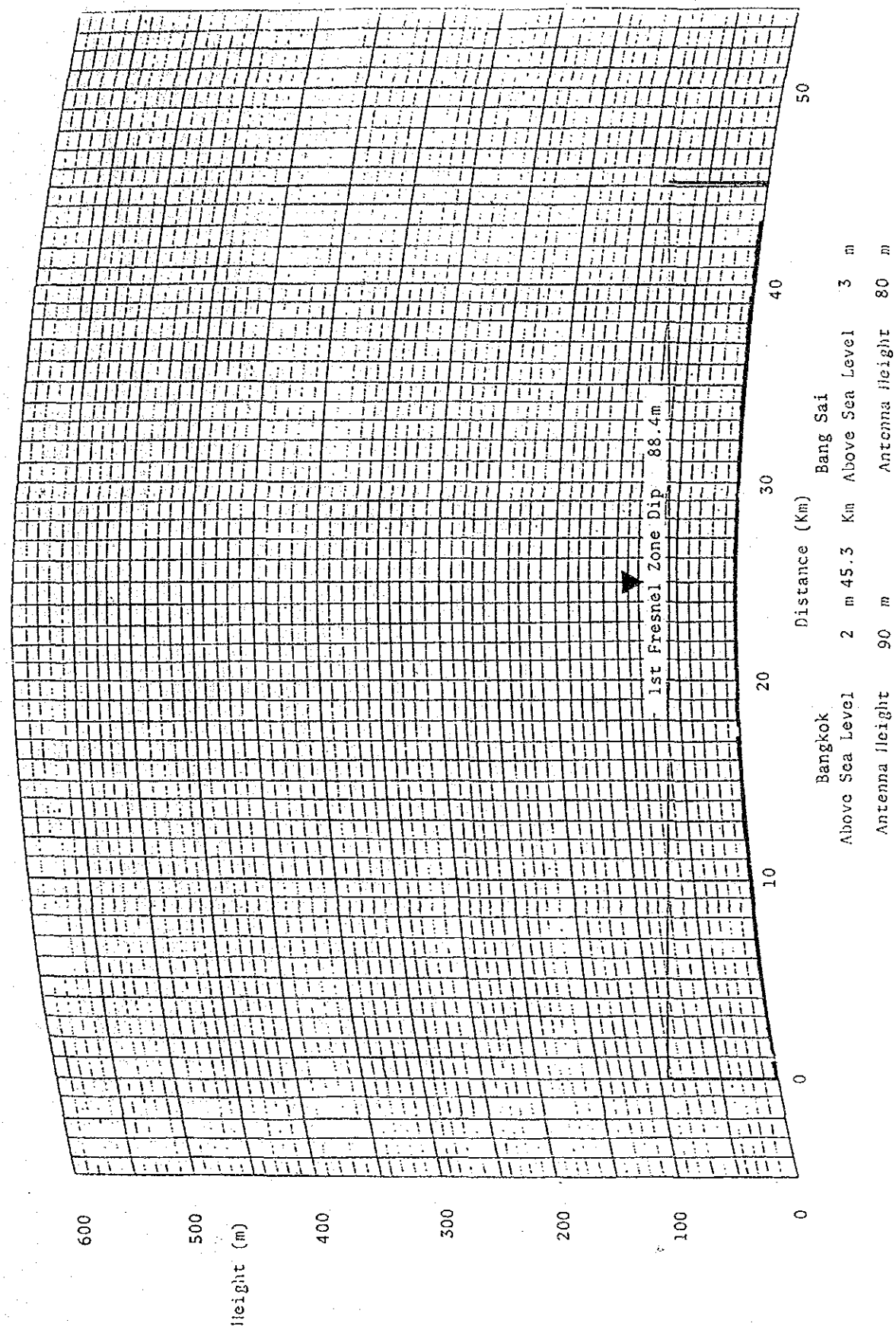
(1) Telemetering System
a) Four water level gauging and rainfall stations
b) Telemetering equipment
c) Central control equipment
d) Computer for data collection

(2) Data Communication System
a) Personal computer for data communication on each office with modem.
b) Additional computers to existing computer in Irrigation Engineering Center.

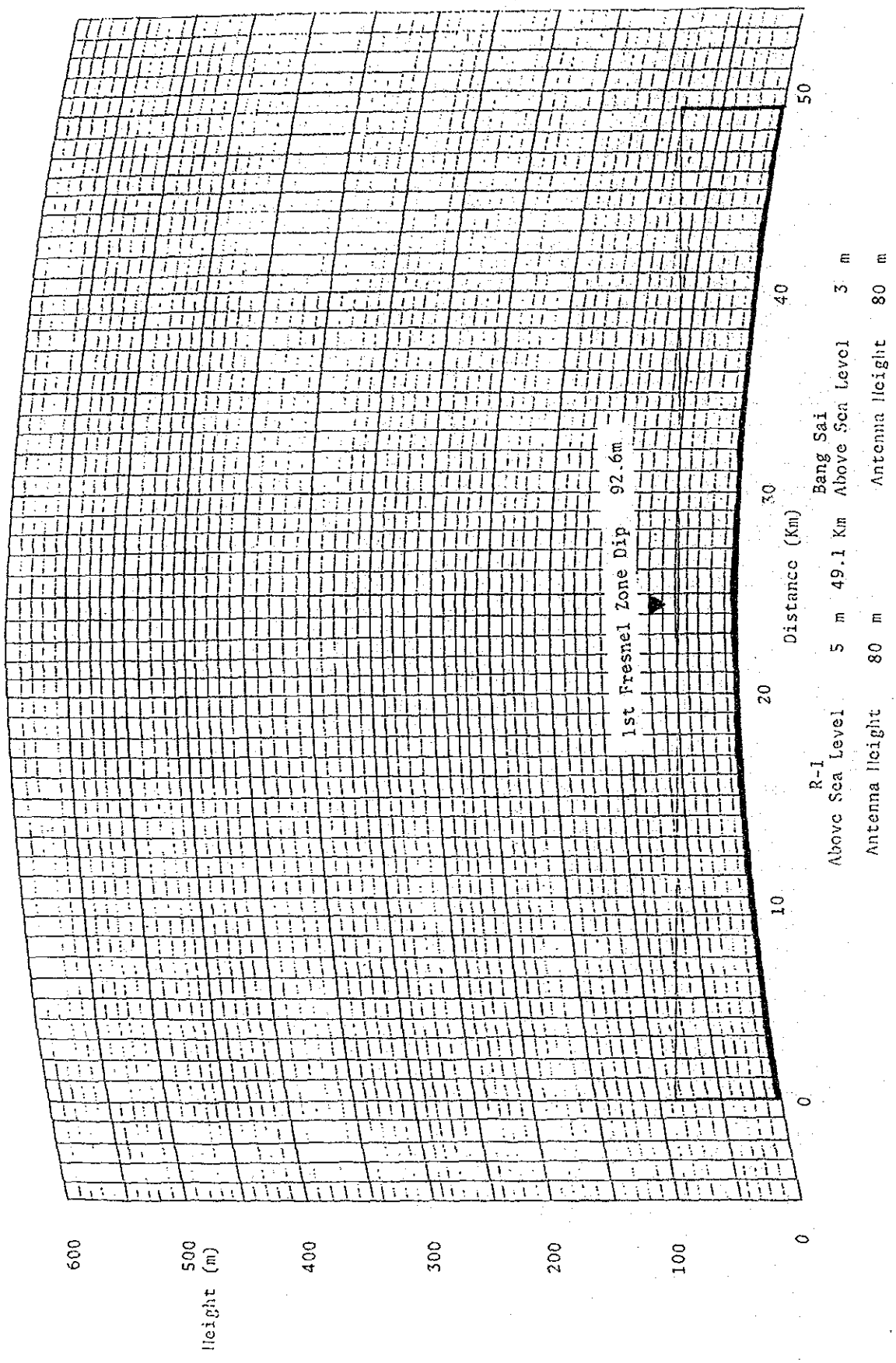
(3) Transmission Line
Transmission line for the system will be by the TOT leased line, because of high quality and reliability, easy maintenance, low initial installation cost , and etc.

LOCATION MAP OF TELEMETERING SYSTEM AND DATA COMMUNICATION SYSTEM

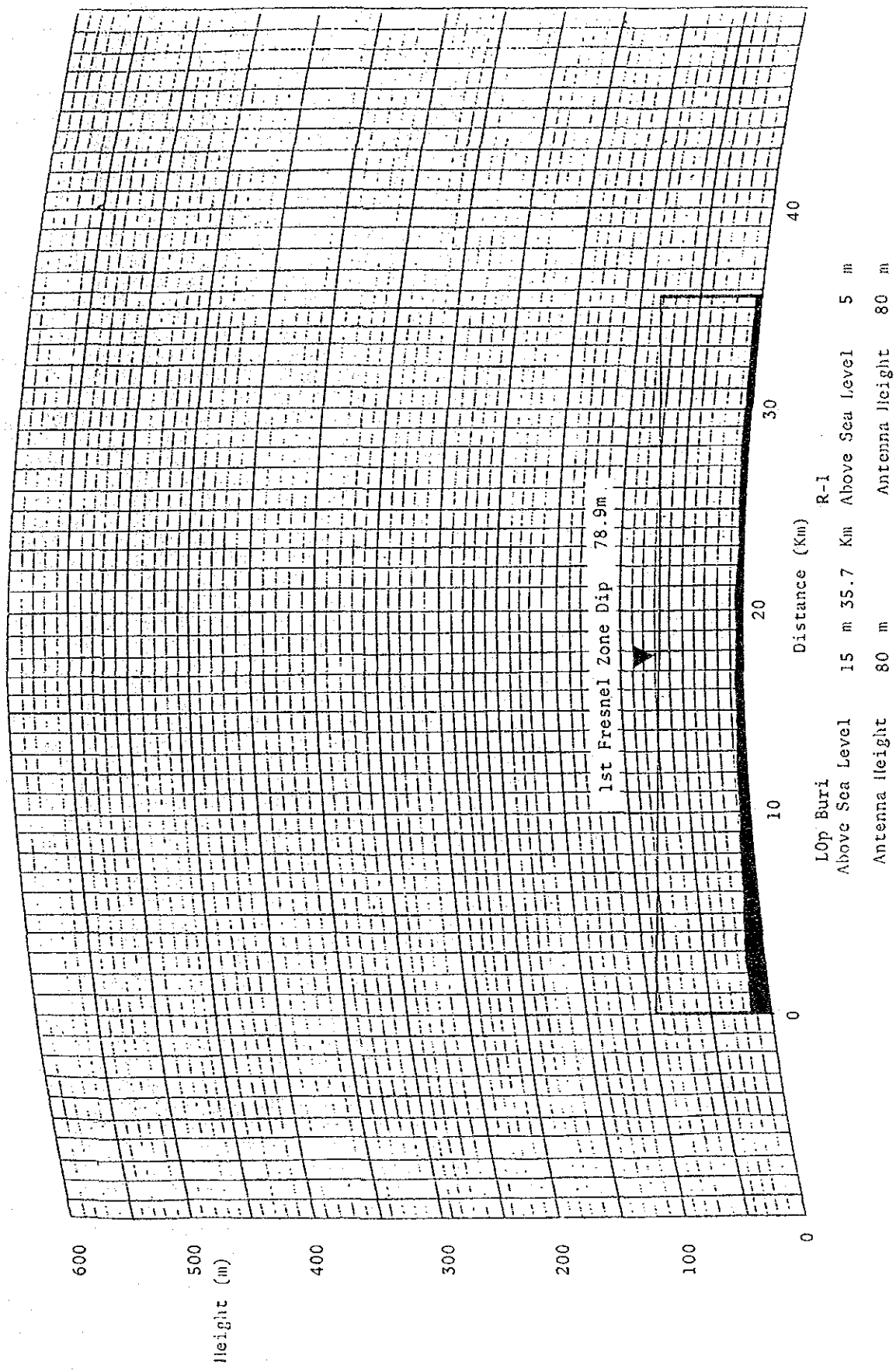




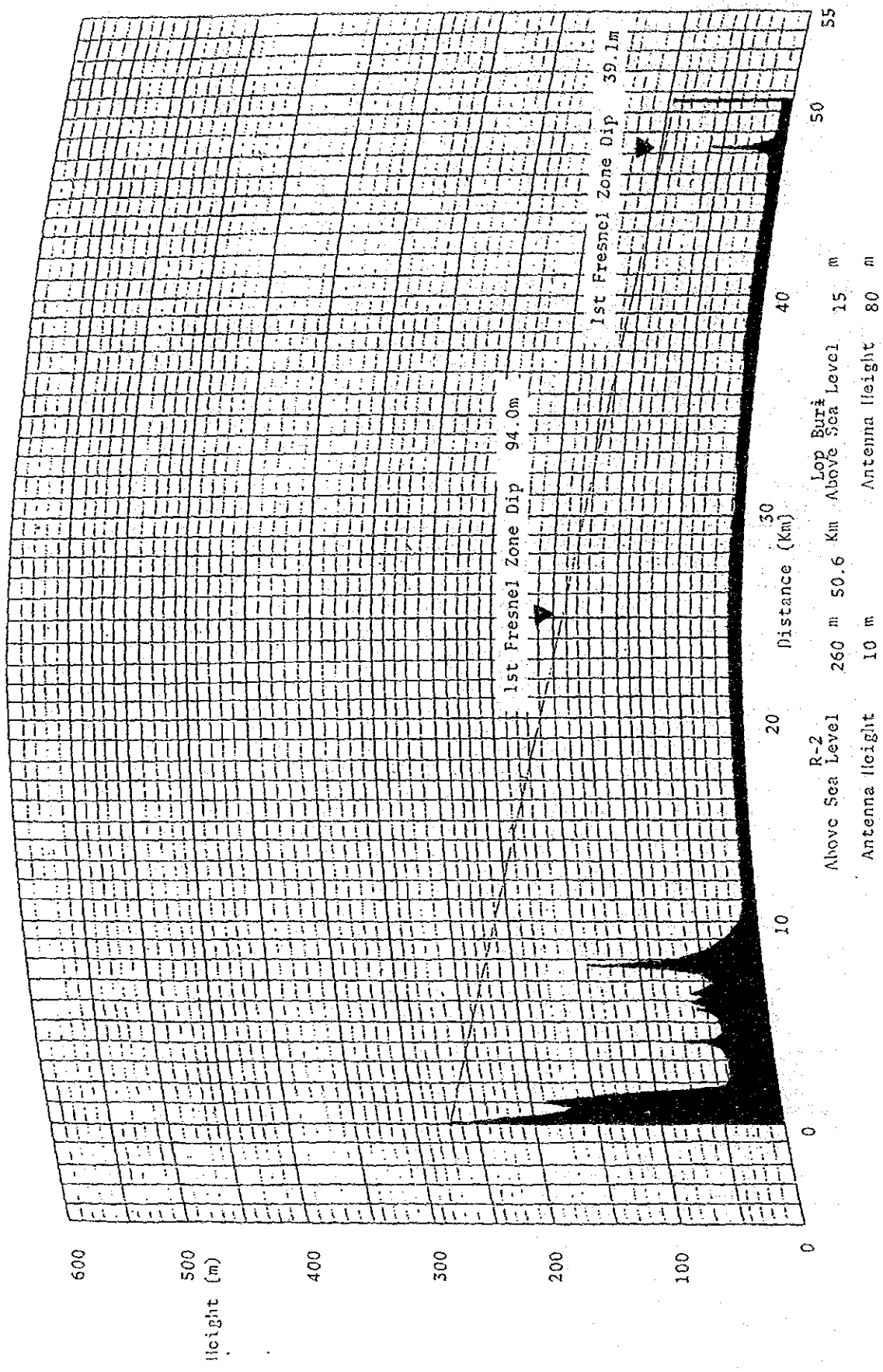
APPENDIX FIG. 1 - 1	PROFILE MAP 1 (BANGKOK ~ BANG SAI)		



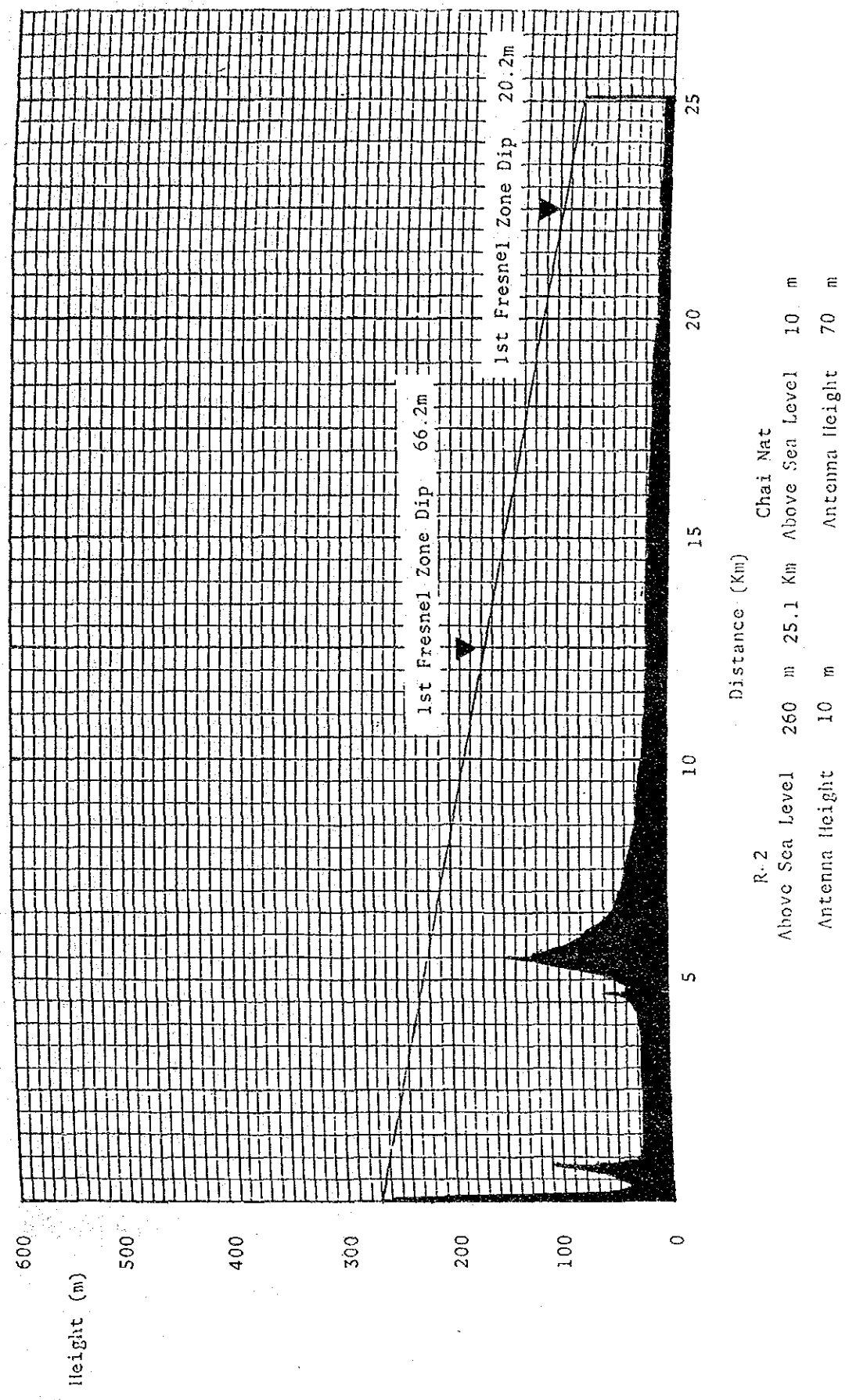
APPENDIX FIG. 1 - 2	PROFILE MAP 2 (R.1 ~ BANG SAI)		



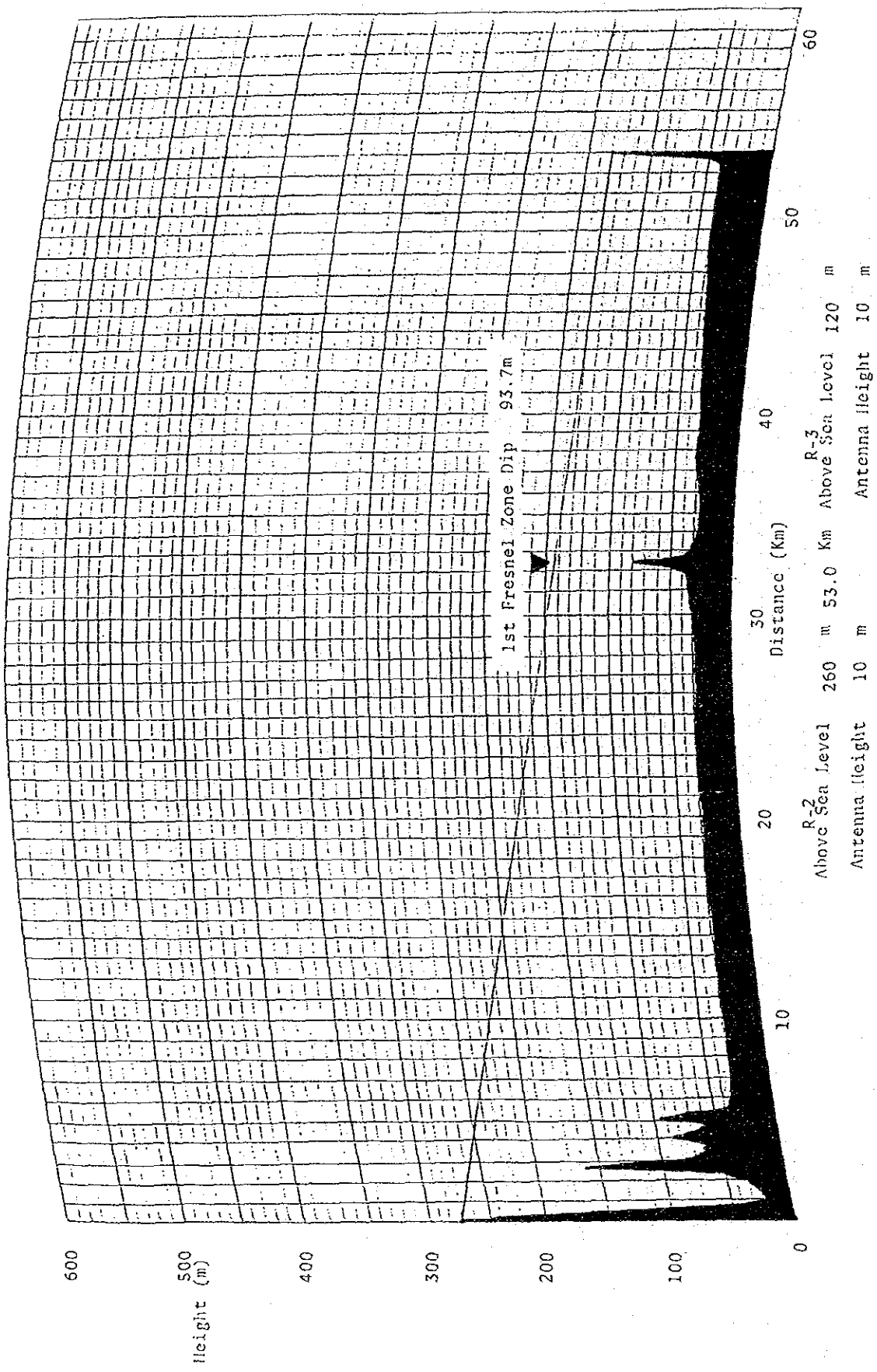
APPENDIX FIG. 1-3	PROFILE MAP 3 (LOP BURI ~ R.1)		



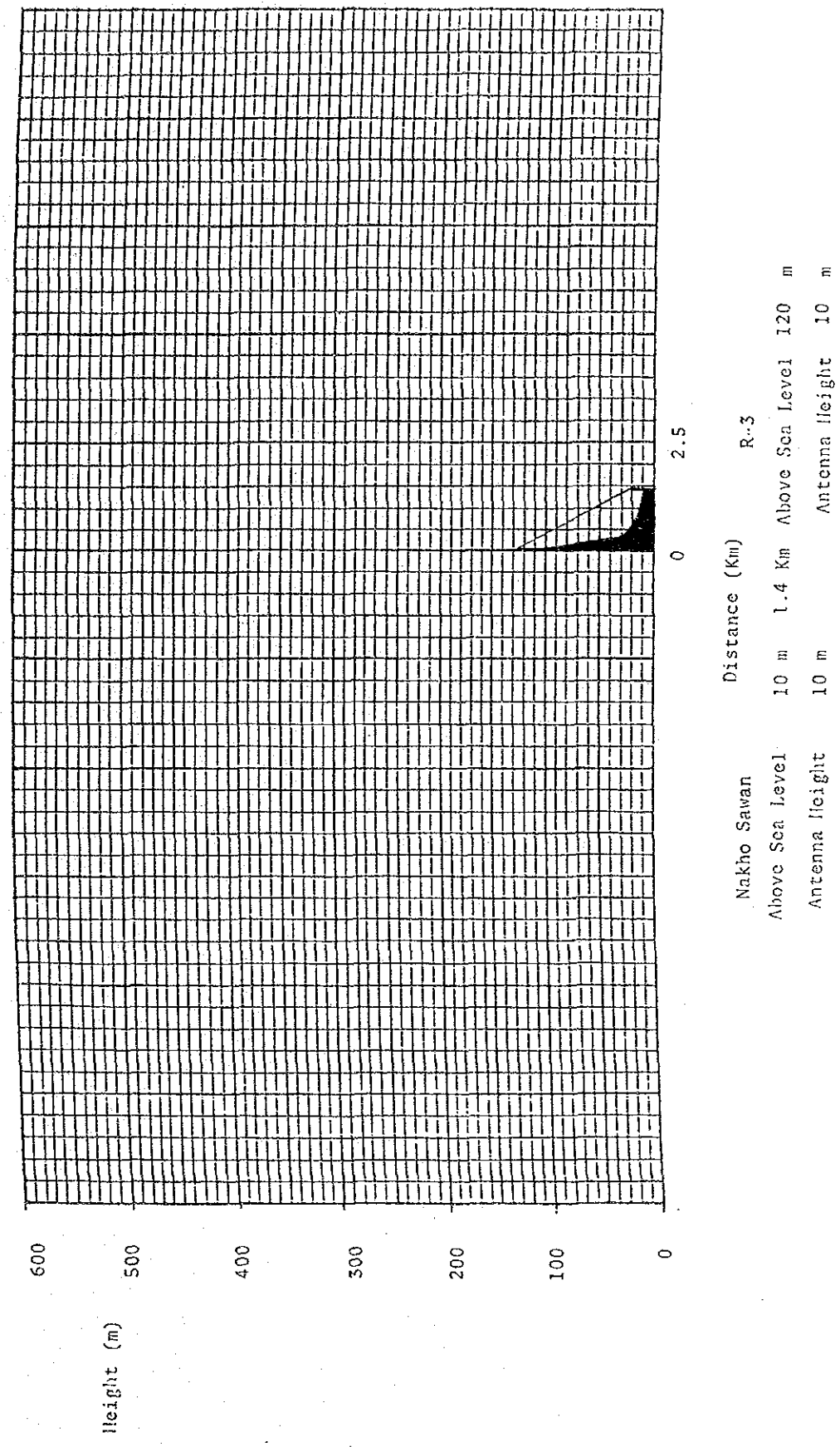
APPENDIX FIG. 1 - 4	PROFILE MAP 4 (R.2 ~ LOP BURI)		



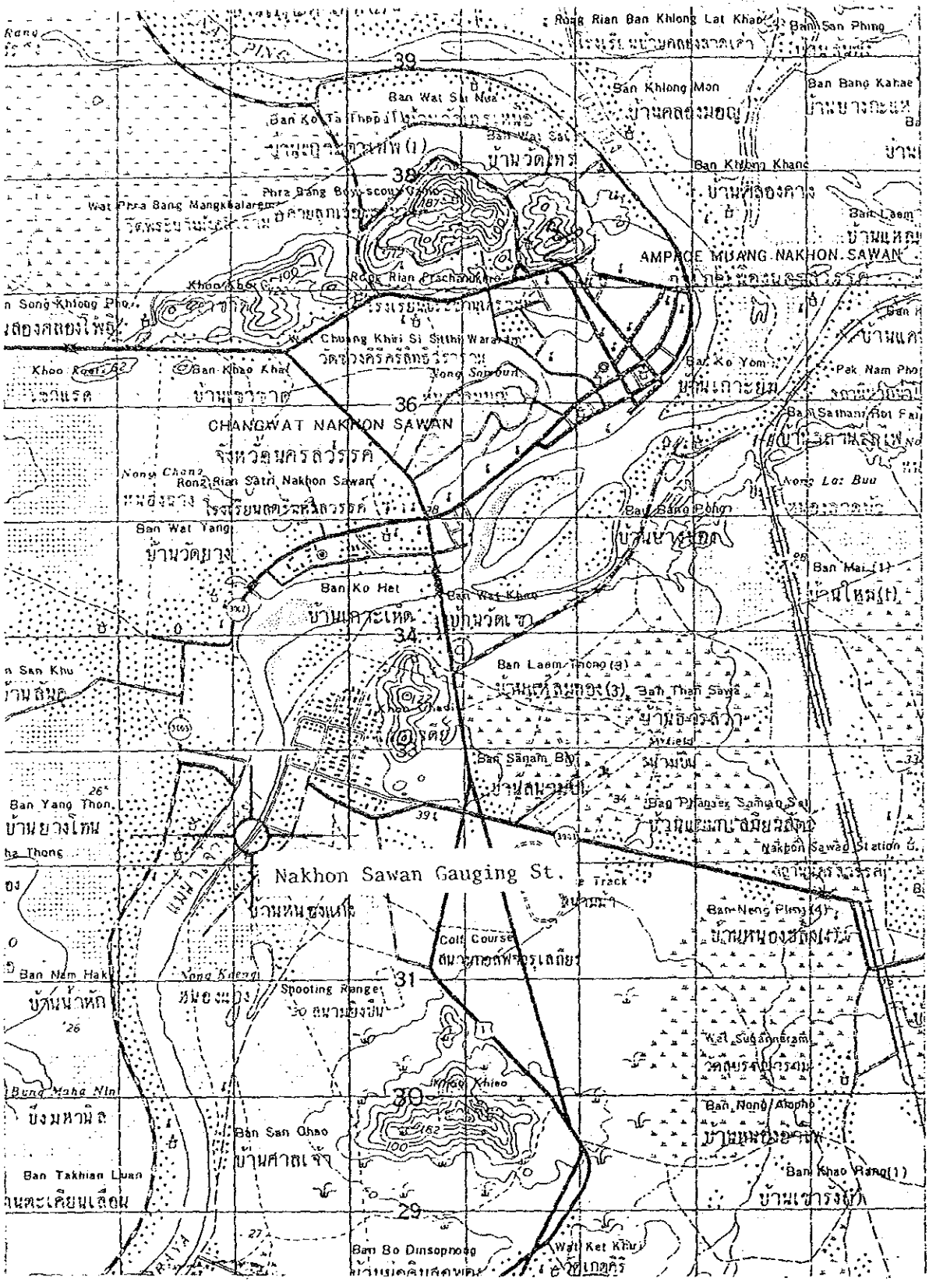
APPENDIX FIG. 1 - 5	PROFILE MAP 5 (R.2 ~ CHAI NAT)		



APPENDIX FIG. 1 - 6	PROFILE MAP 6 (R.2 ~ R.3)		



APPENDIX FIG. 1 - 7	PROFILE MAP 7 (NAKHON SAWAN ~ R.3)		



APPENDIX FIG. 2 - 1	LOCATION MAP OF NAKHON SAWAN GAUGING STATION		